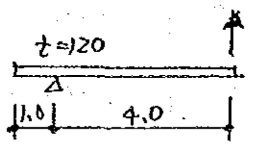
7-5 DESIGN OF PRECAST CONCRETE WALL

The stress is maximum in case of lifting.



$w = 2.4^{T/m^3} \times 0.12 = 0.288$

$M = \frac{1}{8} \times 0.288 \times 4^2 = 0.576\ T\text{-}m$

$Z = \frac{100 \times 12^2}{6} = 2{,}400\ cm^3$

$\sigma = \frac{0.576 \times 10^5}{2{,}400} = 24\ kg/cm^2 < 2\sqrt{Fc} = 28.98\ kg/cm^2$

$at = \frac{57.6}{3.0 \times \frac{7}{8} \times 6.0}$

$= 3.66\ cm^2$ #4 @250 (5.08 cm^2)

8. Calculation of the angle of relative displacement

Direction	FL	Qi (t)	Ki (t/cm)	δ (cm)	Δδ (cm)	h (cm)	$\frac{\Delta\delta}{h} \leqq 1/200$	
Short span	RF	360.4	(228.4)	2.877	1.578	610	1/386	ok
	5TH	613.0		1.299	0.346	500	1/1445	ok
	4TH	830.1		0.953	0.264	500	1/1893	ok
	OPE.	1173.6		0.689	0.305	550	1/1803	ok
	MEZ	1458.2		0.384	0.384	650	1/1692	ok
Long span	RF	327.7	1156.8	1.515	0.283	610	1/2155	ok
	5TH	576.9	2290.4	1.232	0.252	500	1/1984	ok
	4TH	830.1	2871.8	0.980	0.289	500	1/1730	ok
	OPE	1173.6	3862.2	0.691	0.304	550	1/1809	ok
	MEZ	1458.2	3765.4	0.387	0.387	650	1/1679	ok

The displacement of short span is due to computer out put.

The angle of relative displacement on each floor in each direction is less than 1/200.

FORM 04

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Calculation of the angle of relative displacement

UNIT-1 only

Direction	FL	Qi (t)	Ki (t/cm)	δ (cm)	Δδ (cm)	h (cm)	$\frac{\Delta\delta}{h} \leq 1/200$	
Short span	RF	223.7		2.877	1.896	610	1/321	ok
	5TH	423.6	2.875.0	0.981	0.147	500	1/3401	ok
	4TH	593.7	2.922.6	0.834	0.203	500	1/2463	ok
	OPE.	835.0	3.787.9	0.631	0.220	550	1/2500	ok
	MEZ	1.019.4	2.482.3	0.411	0.411	550	1/1338	ok
Long span	RF	204.3	578.4	1.586	0.353	610	1/1728	ok
	5TH	400.0	1.692.8	1.233	0.236	500	1/2118	ok
	4TH	554.1	2.117.7	0.997	0.262	500	1/1908	ok
	OPE	835.0	2.491.9	0.735	0.335	550	1/1641	ok
	MEZ	1.019.4	2.548.0	0.400	0.400	550	1/1375	ok

9. Calculation of the ratios of rigidity and the eccentricity

9-1 THE RATIOS OF RIGIDITY

Direction	FLOOR	γ	$r_s=1/\gamma$	Σr_s, $\overline{r_s}$	$R_s=r_s/\overline{r_s}$	REMARKS
Short span	RF	1/386	386	Σr_s = 7219 $\overline{r_s}$ = 1443.8	0.27 < 6/10	OUT
	5TH	1/1445	1445		1.00 > 6/10	
	4TH	1/1893	1893		1.31 > 6/10	
	OPE	1/1803	1803		1.25 > 6/10	
	MEZ	1/1692	1692		1.17 > 6/10	
Long span	RF	1/2155	2155	Σr_s = 9357 $\overline{r_s}$ = 1871.4	1.15 > 6/10	
	5TH	1/1984	1984		1.06 > 6/10	
	4TH	1/1730	1730		0.92 > 6/10	
	OPE	1/1809	1809		0.97 > 6/10	
	MEZ	1/1679	1679		0.90 > 6/10	

9-2 ECCENTRICITY

FLOOR	W	g_y / g_x	ΣDx / ΣDy	l_y / l_x	e_y / e_x	K_R	r_{ex} / r_{ey}	R_{ex} / R_{ey}	Check
RF	1,638.4	55.8		55.8	0.0	4.28×10^5	19.25	0.0	<0.15
		11.0		11.0	0.0		43.28	0.0	
5TH	3,643.9	55.33		55.8	0.47	6.61×10^6	53.74	0.097	
		20.19		25.42	5.23		39.38	0.012	
4TH	5,572.2	55.95		55.80	0.35	6.98×10^6	49.28	0.039	
		23.97		25.88	1.91		39.21	0.009	
OPE	9,817.8	55.51		55.80	0.29	8.32×10^6	46.42	0.066	
		23.42		20.35	3.07		38.00	0.008	
MEZ	14,619.6	55.69		55.80	0.11	6.03×10^6	40.03	0.076	
		22.72		19.67	3.04		39.81	0.003	

center of gravity
$g_y=\Sigma Wx\cdot Y/\Sigma Wx$
$g_x=\Sigma Wy\cdot X/\Sigma Wy$

Center of rigidity
$l_x=\Sigma Dx\cdot Y/\Sigma Dx$
$l_y=\Sigma Dy\cdot X/\Sigma Dy$

eccentric distance
$e_y=|l_y-g_y|$
$e_x=|l_x-g_x|$

Torsional stiffness
$K_R=\Sigma Dx\cdot \bar{Y}^2+\Sigma Dy\cdot \bar{X}^2$

erastic radius
$r_{ex}=\sqrt{K_R/\Sigma Dx}$
$r_{ey}=\sqrt{K_R/\Sigma Dy}$

eccentricity
$R_{ex}=e_y/r_{ex}$
$R_{ey}=e_x/r_{ey}$

FORM 04

THE RATIOS OF RIGIDITY

UNIT-1 only

Direction	FLOOR	γ	$r_s=1/\gamma$	Σr_s, $\overline{r_s}$	$Rs=r_s/\overline{r_s}$	REMARKS
Short span	RF	1/321	321	Σr_s = 10,023	0.16 < 6/10	OUT
	5TH	1/3401	3401	$\overline{r_s}$ = 2004.6	1.70 > 6/10	
	4TH	1/2463	2463		1.23 > 6/10	
	OPE	1/2500	2500		1.25 > 6/10	
	MEZ	1/1338	1338		0.67 > 6/10	
Long span	RF	1/1728	1728	Σr_s = 8,770	0.99 > 6/10	
	5TH	1/2118	2118	$\overline{r_s}$ = 1,754.0	1.21 > 6/10	
	4TH	1/1908	1908		1.09 > 6/10	
	OPE	1/1641	1641		0.94 > 6/10	
	MEZ	1/1375	1375		0.78 > 6/10	

ECCENTRICITY

FLOOR	W	g_y / g_x	ΣDx / ΣDy	l_y / l_x	e_y / e_x	K_R	γex / γey	Rex / Rey	Check
RF	972.8	32.27		28.27	4.00	1.17×10^5	14.23	0.000	< 0.15
		11.00		11.00	0.00		30.16	0.133	< 0.15
5TH	2,391.3	35.67		34.95	0.72	2.42×10^6	37.78	0.215	> 0.15 OUT
		21.68		29.81	8.13		28.99	0.025	< 0.15
4TH	3,996.3	40.78		33.05	7.72	2.24×10^6	32.54	0.135	< 0.15
		25.80		30.20	4.40		27.70	0.279	> 0.15 OUT
OPE	6,996.2	40.76		35.08	5.68	2.90×10^6	39.14	0.024	< 0.15
		25.52		24.69	0.83		27.69	0.205	> 0.15 OUT
MEZ	10,231.6	40.17		34.22	5.95	1.86×10^6	33.30	0.274	> 0.15 OUT
		25.00		15.88	9.12		27.34	0.218	> 0.15 OUT

center of gravity
$g_y=\Sigma Wx\cdot Y/\Sigma Wx$
$g_x=\Sigma Wy\cdot X/\Sigma Wy$

Center of rigidity
$l_x=\Sigma Dx\cdot Y/\Sigma Dx$
$l_y=\Sigma Dy\cdot X/\Sigma Dy$

eccentric distance
$e_y=|l_y-g_y|$
$e_x=|l_x-g_x|$

Torsional stiffness
$K_R=\Sigma Dx\cdot \overline{Y}^2+\Sigma Dy\cdot \overline{X}^2$

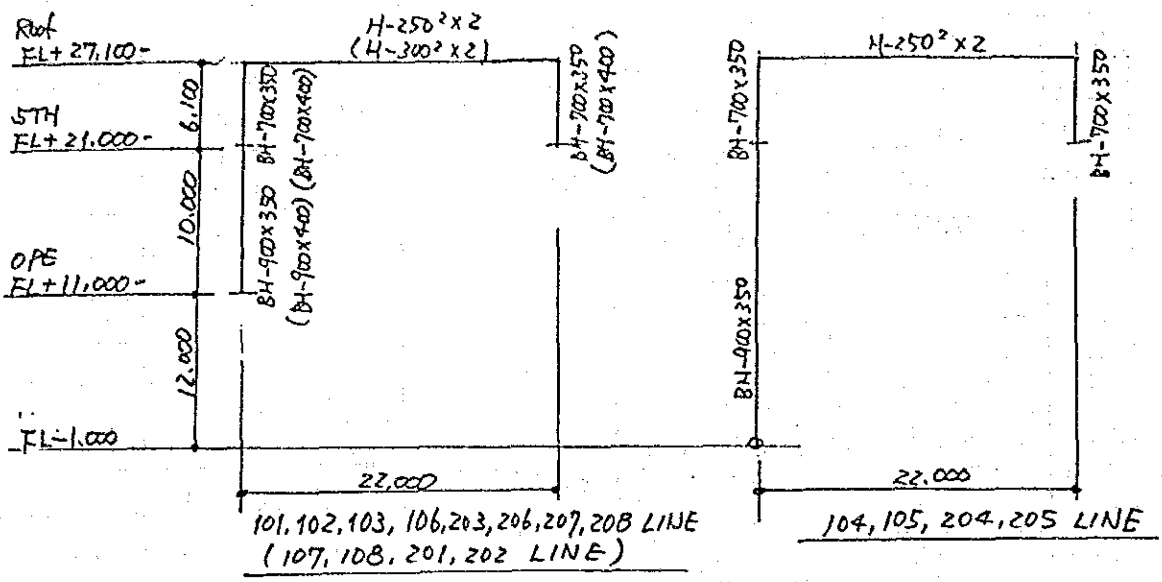
erastic radius
$\gamma e_x=\sqrt{K_R/\Sigma Dx}$
$\gamma e_y=\sqrt{K_R/\Sigma Dy}$

eccentricity
$Rex=e_y/\gamma ex$
$Rey=e_x/\gamma ey$

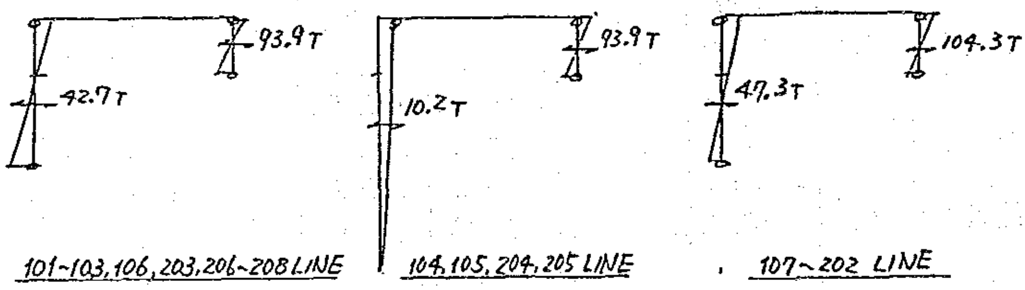
FORM 04

10-1 CALCULATION OF POTENTIAL HORIZONTAL BEARING STRENGTH

1) Roof FL.



MEMBER	Zp (cm³)	Ultimate bending moment (t.m)
BH-900x350x28x40	16,746.8	401.9
BH-900x400x28x40	18,466.8	443.2
BH-700x350x28x40	11,930.8	286.3
BH-700x400x28x40	13,250.8	318.0
H-250² x2	14,287.9	342.9
H-300²x2	17,970.0	431.2



$\Sigma Q_P = 2,115.6$ T

Potential Horizontal Bearing Strength of Vertical Brace (1)

FL	Location	Member	B (cm)	H (cm)	L (cm)	Ag (cm²)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
101	LINE												
5TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-10.6)x2= 412.4	291.6	291.6
4TH	G-H	H-250² (K)	500	500	707	92.18	6.29	112	1.56	143.8	(143.8-11.5)x2= 264.6	187.1	187.1
OPE	A-B	2L-120x8 (X)	450	550	(355) 710	37.52	3.71	96	1.78	66.8	66.8x2= 133.6	84.6	
	D-F	Ditto (X)	600	550	(406) 813	37.52	3.71	109	1.60	60.0	60.0x2= 120.0	88.5	
	G-H	H-250² (K)	500	550	743	92.18	6.29	118	1.47	135.5	(135.5-19.1)x2= 232.8	156.6	329.7
MEZ	B-D	2L-120x8 (X)	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4x2= 108.8	73.8	
	D-F	Ditto	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4x2= 108.8	73.8	
	F-G	Ditto	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4x2= 114.8	74.1	
	G-H	H-300² (K)	500	650	820	119.8	7.51	109	1.60	191.6	(191.6-16.0)x2= 351.2	214.1	435.8
102	LINE												
4TH	G-H	H-250² (K)	500	500	707	92.18	6.29	112	1.56	143.8	(143.8-38.9)x2= 209.8	148.3	148.3
OPE	A-B	2L-120x8 (X)	450	550	(355) 710	37.52	3.71	95	1.79	67.1	67.1x2= 134.2	85.0	
	G-H	H-250² (K)	500	550	743	92.18	6.29	118	1.47	135.5	(135.5-19.7)x2= 231.6	155.8	240.8
MEZ	A-B	H-300² (N)	450	650	790	119.8	7.51	105	1.66	198.8	198.8	113.2	
	B~D D~F	2L-120x8 (X)	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4x2= 108.8	73.8	
	F-G	Ditto	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4x2= 114.8	74.1	334.9

$L = \sqrt{B^2 + H^2}$

$\lambda = L / i$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}} = 120$

$N_t = Ag \cdot F$, $N_c = Ag \cdot \sigma_{cr}$

$\lambda \le \Lambda$ $\quad \sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$

$\lambda > \Lambda$ $\quad \sigma_{cr} = \frac{0.6F}{(\lambda/\Lambda)^2}$

$_BQu = Nu * (L/B)$

$\lambda \ge \frac{200}{\sqrt{F}} = 129$ $\quad Nu = Nt$

$\frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}} = 32$ $\quad Nu = 2Nc$

$\lambda \le \frac{50}{\sqrt{F}}$ $\quad Nu = 2Nt$

Potential Horizontal Bearing Strength of Vertical Brace (2)

FL	Location	Member	B (cm)	H (cm)	L (cm)	Ag (cm2)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
103	LINE												
5TH	G-H	H-350² (K)	500	500	707	173.9	8.84	79	1.98	344.3	(344.3-126.6)×2= 435.4	307.9	307.9
4TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-53.6)×2= 326.4	230.8	230.8
OPE	A-B	2L-130×12 (N)	450	550	710	59.52	3.96	179		(142.8)			
	F-G	2L-120×8 (X)	550	550	(388) 777	37.52	3.71	104	1.67	62.6	62.6×2= 125.2	88.6	
	G-H	H-250² (K)	500	550	743	92.18	6.29	118	1.47	135.5	(135.5-19.7)×2= 231.6	155.8	244.4
ME8	A-B	H-300² (N)	450	650	790	119.8	7.51	105	1.66	198.8	198.8	113.2	
	F-G	2L-120×8 (X)	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4×2= 114.8	74.1	187.3
104	LINE												
5TH	G-H	H-350² (K)	500	500	707	173.9	8.84	79	1.98	344.3	(344.3-126.6)×2= 435.4	307.9	307.9
4TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-66.8)×2= 300.0	212.1	212.1
OPE	G-H	H-250² (K)	500	550	743	92.18	6.29	118	1.47	135.5	(135.5-23.0)×2= 225.0	151.4	151.4
105	LINE												
4TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-66.8)×2= 300.0	212.1	212.1
OPE	G-H	H-250² (K)	500	550	743	92.18	6.29	118	1.47	135.5	(135.5-23.0)×2= 225.0	151.4	151.4

$_BQu = Nu * (L/B)$

$L = \sqrt{B^2 + H^2}$ $\quad N_t = A_g \cdot F,\ N_c = A_g \cdot \sigma_{cr}$ $\quad \lambda \geq \frac{200}{\sqrt{F}}$ $\quad N_u = N_t$

$\lambda = L/i$ $\quad \lambda \leq \Lambda \quad \sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$ $\quad \frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_c$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6F}}$ $\quad \lambda > \Lambda \quad \sigma_{cr} = \frac{0.6F}{(\lambda/\Lambda)^2}$ $\quad \lambda \leq \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_t$

Potential Horizontal Bearing Strength of Vertical Brace (3)

FL	Loca-tion	Member	B (cm)	H (cm)	L (cm)	Ag (cm²)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
106	LINE												
5TH	H-K	H-300² (K)	700	500	860	119.8	7.51	114	1.53	183.3	(183.3-21.8) ×2= 323.0	262.9	262.9
4TH	H-K	H-250² (K)	700	500	860	92.18	6.29	136		221.2	221.2	180.0	180.0
OPE	A-B	2L-130×12 (N)	450	550	710	59.52	3.96	179		(142.8)			
	F-G	2L-120×8 (X)	550	550	(388) 777	37.52	3.71	104	1.67	62.6	62.6×2= 125.2	88.6	
	H-K	H-300² (K)	700	550	890	119.8	7.51	118	1.47	176.1	(176.1-19.7) ×2= 312.8	246.0	334.6
MEZ	A-B	H-300² (N)	450	650	790	119.8	7.51	105	1.66	198.8	198.8	113.2	
	F-G	2L-120×8 (X)	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4×2= 114.8	74.1	
	H-K	H-300² (K)	700	650	955	119.8	7.51	127	1.28	153.3	(153.3-22.6) ×2= 261.4	191.6	378.9
107	LINE												
5TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-23.5) ×2= 386.6	273.4	273.4
OPE	A-B	2L-130×12 (N)	450	550	710	59.52	3.96	179		(142.8)			
	F-G	2L-120×8 (X)	550	550	(275) 777	37.52	3.71	74	2.03	76.1	76.1×2= 152.2	107.7	107.7
MEZ	A-B	H-300² (N)	450	650	790	119.8	7.51	105	1.66	198.8	198.8	113.2	
	B-D	2L-120×8 (X)	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4×2= 108.8	73.8	
	D-F	Ditto	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4×2= 108.8	73.8	
	F-G	Ditto	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4×2= 114.8	74.1	334.9

$_BQ_u = N_u \times (L/B)$

$L = \sqrt{B^2 + H^2}$ $\quad N_t = A_g \cdot F,\ N_c = A_g \cdot \sigma_{cr}$ $\quad \lambda \geq \frac{200}{\sqrt{F}}$ $\quad N_u = N_t$

$\lambda = L/i$ $\quad \lambda \leq \Lambda$ $\quad \sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$ $\quad \frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_c$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}}$ $\quad \lambda > \Lambda$ $\quad \sigma_{cr} = \frac{0.6 F}{(\lambda/\Lambda)^2}$ $\quad \lambda \leq \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_t$

FORM 04

Potential Horizontal Bearing Strength of Vertical Brace (4)

FL	Loca-tion	Member	B (cm)	H (cm)	L (cm)	Ag (cm2)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
108	LINE												
4TH	G-H	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-50.3)×2= 333.0	235.5	235.5
OPE	D-F	2L-120×8 (X)	600	550	(406) 813	37.52	3.71	109	1.60	60.0	60.0×2= 120.0	88.5	
	F-G	Ditto	550	550	(388) 777	37.52	3.71	104	1.67	62.6	62.6×2= 125.2	88.6	
	H-K	H-300² (K)	700	550	890	119.8	7.51	118	1.47	176.1	(176.1-14.3)×2= 323.8	254.6	431.7
MEZ	A-B	H-300² (N)	450	650	790	119.8	7.51	105	1.66	198.8	198.8	113.2	
	B-D	2L-120×8 (X)	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4×2= 108.8	73.8	
	D-F	Ditto	600	650	(442) 884	37.52	3.71	119	1.45	54.4	54.4×2= 108.8	73.8	
	F-G	Ditto	550	650	(425) 851	37.52	3.71	114	1.53	57.4	57.4×2= 114.8	74.2	335.0

$_BQu = Nu * (L/B)$

$L = \sqrt{B^2 + H^2}$ $\quad Nt = Ag \cdot F,\ Nc = Ag \cdot \sigma_{cr}$ $\quad \lambda \geq \frac{200}{\sqrt{F}}$ $\quad Nu = Nt$

$\lambda = L/i$ $\quad \lambda \leq \Lambda \quad \sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$ $\quad \frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $\quad Nu = 2Nc$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}}$ $\quad \lambda > \Lambda \quad \sigma_{cr} = \frac{0.6F}{(\lambda/\Lambda)^2}$ $\quad \lambda \leq \frac{50}{\sqrt{F}}$ $\quad Nu = 2Nt$

Potential Horizontal Bearing Strength of Vertical Brace (5)

FL	Location	Member	B (cm)	H (cm)	L (cm)	Ag (cm2)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
A	LINE												
Roof	102-103 106-107 202-203 206-207	(X) 2L-120²×8	680	610	(456) 913	37.52	3.71	122	1.39	52.1	52.1×2= 104.2	77.6	
	107-108 201-202	Ditto	1000	610	(585) 1171	37.52	3.71	157		90.0	90.0	76.8	464.0
5TH	102-103 106-107 202-203 206-207	Ditto	680	500	(422) 844	37.52	3.71	113	1.54	57.7	57.7×2= 115.4	92.9	
	107-108 201-202	Ditto	1000	500	(559) 1118	37.52	3.71	150		90.0	90.0	80.5	532.6
4TH	102-103 106-107 202-203 206-207	(X) 2L-130×9	680	500	(422) 844	45.48	4.01	105	1.66	75.4	75.4×2= 150.8	121.5	
	107-108 201-202	Ditto	1000	500	(559) 1118	45.48	4.01	139		109.1	109.1	97.5	675.0
OPE	102-103 106-107 202-203 206-207	Ditto	680	550	(437) 874	45.48	4.01	108	1.62	73.6	73.6×2= 147.2	114.5	
	107-108 201-202	Ditto	1,000	550	(570) 1141	45.48	4.01	142		109.1	109.1	95.6	649.2
MEZ	102-103 106-107 202-203 206-207	(X) 2L-130×12	680	650	(470) 940	59.52	3.96	118	1.47	87.5	87.5×2= 175.0	126.6	
	107-108 201-202	Ditto	1,000	650	(596) 1192	59.52	3.96	150		142.8	142.8	119.8	746.0
B	LINE												
OPE	102-103 206-207	(K) H-250²	340	550	646	92.18	6.29	102	1.70	156.7	(156.7-55.1)×2= 101.6	53.4	
	106-107 202-203	Ditto	340	550	646	92.18	6.29	102	1.70	156.7	(156.7-48.0)×2= 217.4	114.4	335.6
MEZ	102-103 206-207	(K) H-300²	340	650	733	119.8	7.51	97	1.77	212.0	(212.0-25.7)×2= 372.6	172.8	
	106-107 202-203	Ditto	340	650	733	119.8	7.51	97	1.77	212.0	(212.0-8.9)×2= 406.2	188.4	722.4

$_BQu = Nu * (L/B)$

$L = \sqrt{B^2 + H^2}$ $Nt = Ag \cdot F$, $Nc = Ag \cdot \sigma_{cr}$ $\lambda \geq \frac{200}{\sqrt{F}}$ $Nu = Nt$

$\lambda = L/i$ $\lambda \leq \Lambda$ $\sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$ $\frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $Nu = 2Nc$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}}$ $\lambda > \Lambda$ $\sigma_{cr} = \frac{0.6F}{(\lambda/\Lambda)^2}$ $\lambda \leq \frac{50}{\sqrt{F}}$ $Nu = 2Nt$

FORM 04

Potential Horizontal Bearing Strength of Vertical Brace (6)

FL	Location	Member	B (cm)	H (cm)	L (cm)	Ag (cm²)	i min (cm)	λ	σcr (T/cm²)	Nt,Nc (t)	Nu (t)	BQu (t)	ΣBQu (t)
F	LINE												
OPE	102-103 206-207	H-250² (K)	340	550	646	92.18	6.29	102	1.70	156.7	(156.7-50.1)×2= 213.2	112.2	
	106-107 202-203	Ditto	340	550	646	92.18	6.29	102	1.70	156.7	(156.7-19.5)×2= 274.4	149.4	513.2
MEZ	102-103 206-207	H-300² (K)	340	650	733	119.8	7.51	97	1.77	212.0	(212.0-27.6)×2= 368.8	171.1	
	106-107 202-203	Ditto	340	650	733	119.8	7.51	97	1.77	212.0	(212.0-10.8)×2= 402.4	186.7	715.6
G	LINE												
Roof	102-103 105-106 203-204 206-207	2L-120×8 (X)	680	610	(456) 913	37.52	3.71	122	1.39	52.1	52.1×2= 104.2	77.6	
	~~107-108~~ 201-202	Ditto	1000	610	(585) 1171	37.52	3.71	157		90.0	90.0	76.8	464.0
MEZ	102-103 105-106 203-204 206-207	H-300² (K)	340	650	733	119.8	7.51	97	1.77	212.0	(212.0-32.4)×2= 359.2	166.6	
	107-108 201-202	H-350² (K)	500	650	820	173.9	8.84	92	1.83	318.2	(318.2-49.7)×2= 537.0	327.4	1321.2
H	LINE												
5TH	102-103 105-106 203-204 206-207	2L-120×8 (X)	680	500	(422) 844	37.52	3.71	113	1.54	57.7	57.7×2= 115.4	92.9	
	107-108 201-202	H-250² (K)	500	500	707	92.18	6.29	112	1.56	143.8	(143.8-27.0)×2= 233.6	165.2	702.0
4TH	102-103 105-106 203-204 206-207	2L-130×9 (X)	680	500	(422) 844	45.48	4.01	105	1.66	75.4	75.4×2= 150.8	121.5	
	107-108 201-202	H-300² (K)	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-54.4)×2= 324.8	229.7	945.4
OPE	102-103 105-106 203-204 206-207	2L-130×9 (X)	680	550	(437) 874	45.48	4.01	108	1.62	73.6	73.6×2= 147.2	114.5	
	107-108 201-202	H-300² (K)	500	550	743	119.8	7.51	98	1.75	209.6	(209.6-87.4)×2= 244.4	164.4	786.8

$_BQ_u = N_u \times (L/B)$

$L = \sqrt{B^2 + H^2}$ $\qquad N_t = A_g \cdot F,\ N_c = A_g \cdot \sigma_{cr}$ $\qquad \lambda \geq \frac{200}{\sqrt{F}}$ $\quad N_u = N_t$

$\lambda = L / i$ $\qquad \lambda \leq \Lambda \quad \sigma_{cr} = \{1 - 0.4(\frac{\lambda}{\Lambda})^2\} \cdot F$ $\qquad \frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_c$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}}$ $\qquad \lambda > \Lambda \quad \sigma_{cr} = \frac{0.6F}{(\lambda/\Lambda)^2}$ $\qquad \lambda \leq \frac{50}{\sqrt{F}}$ $\quad N_u = 2N_t$

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Potential Horizontal Bearing Strength of Vertical Brace (7)

FL	Location	Member	B (cm)	H (cm)	L (cm)	Ag (cm2)	i min (cm)	λ	σ_{cr} (T/cm²)	Nt, Nc (t)	Nu (t)	$_B Qu$ (t)	$\Sigma _B Qu$ (t)
MEZ	102-103 105-106 203-204 206-207	(X) 2L-130×12	680	650	(470) 940	59.52	3.96	118	1.47	87.5	87.5×2= 175.0	126.6	
	107-108 201-202	(K) H-350²	500	650	820	173.9	8.84	92	1.83	318.2	(318.2-83.3)×2= 469.8	286.4	1,079.2
K	LINE												
5TH	107-108 201-202	(K) H-250²	500	500	707	92.18	6.29	112	1.56	143.8	(143.8-24.7)×2= 238.2	168.4	336.8
4TH	107-108	(K) H-300²	500	500	707	119.8	7.51	94	1.81	216.8	(216.8-33.2)×2= 367.2	259.6	
	201-202	Ditto	500	500	707	119.8	7.51	94	1.81	216.8	(211.8-23.5)×2= 386.6	273.4	533.0
OPE	107-108 108-201	(K) H-300²	500	550	743	119.8	7.51	98	1.75	209.6	(209.6-32.2)×2= 354.8	238.7	477.4
MEZ	106-107 202-203	(X) 2L-130×12	680	650	(470) 940	59.52	3.96	118	1.47	87.5	87.5×2= 175.0	126.6	253.2

$L = \sqrt{B^2 + H^2}$ $N_t = A_g \cdot F$, $N_c = A_g \cdot \sigma_{cr}$ $_B Q_u = N_u \times (L/B)$

$\lambda = L / i$ $\lambda \leq \Lambda$ $\sigma_{cr} = \{1 - 0.4 (\frac{\lambda}{\Lambda})^2\} \cdot F$ $\lambda \geq \frac{200}{\sqrt{F}}$ $N_u = N_t$

$\Lambda = \sqrt{\frac{\pi^2 E}{0.6 F}}$ $\lambda > \Lambda$ $\sigma_{cr} = \frac{0.6 F}{(\lambda/\Lambda)^2}$ $\frac{200}{\sqrt{F}} > \lambda > \frac{50}{\sqrt{F}}$ $N_u = 2 N_c$

$\lambda \leq \frac{50}{\sqrt{F}}$ $N_u = 2 N_t$

10-2 Calculation of reguired potential horizontal bearing strength

$Qun = Ds \cdot Fes \cdot Qud$

Qud : Reguired potential horizontal bearing strength on each floor.

Ds : Coefficient of structural characteristic on each floor.

Fes : Coefficient of shape characteristic on each floor.

Qud : Horizontal force by seismic load on each floor.

1) Decision of Ds (see table)

i) Classification of columns and girders

a) Column

$B/tf = 4.4 \sim 10$ → FB } → FB
$d/tw = 20 \sim 27.5$ → FA

b) Girdes

→ FA

ii) Classification of vertical bracing

$\lambda_e = 74 \sim 150$ $\left(\frac{90}{\sqrt{F}} = 58, \frac{200}{\sqrt{F}} = 129.1 \right)$

→ BC

iii) βu

a). Roof FL. short span

$\beta u = 0$

b) other floors

$\beta u = 1.0$

iv) The value of Ds

a) Roof FL. short span

$Ds = 0.3$

b) other floors

$Ds = 0.4$

2) Calculation of Fes

$Fes = Fe \cdot Fs$

i) Fe

a) Roof FL

$Re < 0.15 \longrightarrow Fe = 1.0$

b) Other floors

$Re < 0.15 \longrightarrow Fe = 1.0$ UNIT 1 & 2

$Re > 0.15 \longrightarrow Fe =$ Due to the number. UNIT-1 only

ii) Fs

a) Roof FL. short span

$Rs < 0.6 \longrightarrow Fs = 1.5$

b) Other floors

$Rs > 0.6 \longrightarrow Fs = 1.0$

3) Calculation of Qud

$Qud = Z \cdot Rt \cdot Ai \cdot Co \cdot Wi$

$Z = 1.0$ Zone factor

$Rt = 1.0$

$$Ai = 1 + \left(\frac{1}{\sqrt{\alpha_i}} - \alpha_i\right) \frac{2T}{1+3T}$$

α_i: ratio of the weight of ith story to the total weight of the building.

T: natural period of the structure.

$Co = 0.5$ standard coefficient of shear force.

Wi: the weight above ith story.

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Table for calculation of Ds value

Table 13-2 (1)

Frame / STRUCTURE	(a) ∘Rigid frame ∘Frame with bracing of class BA ∘Except for above and frame with bracing of $\beta u \leq 0.3$	(b) Frame with Bracing of class BB and $0.3 \leq \beta u \leq 0.7$, or class BC and $0.3 < \beta u \leq 0.5$	(c) Frame with Bracing of class BB and $\beta u > 0.7$, or class BC and $\beta u > 0.5$
(1) RANK I	0.25	0.3	0.35
(2) RANK II	0.3	0.35	0.4
(3) RANK III	0.35	0.4	0.45
(4) RANK IV	0.40	0.45	0.5

Remarks: RANK OF STRUCTURE are shown in Table 13-2 (2)

$$\beta u = \frac{\text{Potential Horizontal Bearing Strength of bracings}}{\text{Total Potential Horizontal Bearing Strength of a Floor}}$$

Table 13-2 (2)

CLASS OF BRACINGS AND βu / CLASS OF COLUMNS AND GURDERS	BA OR $\beta u = 0$	BB			BC		
		$\beta u \leq 0.3$	$0.3 < \beta u \leq 0.7$	$\beta u > 0.7$	$\beta u \leq 0.3$	$0.3 < \beta u \leq 0.5$	$\beta u > 0.5$
CLASS FA	I (0.25)	I (0.25)	I (0.3)	I (0.35)	II (0.3)	II (0.35)	II (0.4)
CLASS FB	II (0.3)	II (0.3)	I (0.3)	I (0.35)	II (0.3)	II (0.35)	II (0.4)
CLASS FC	III (0.35)	III (0.35)	II (0.35)	II (0.4)	III (0.35)	III (0.4)	III (0.45)
OTHERS FD	IV (0.4)	IV (0.4)	IV (0.45)	IV (0.5)	IV (0.4)	IV (0.45)	IV (0.5)

Table 13-2 (3)

BA	BB		BC
$\lambda_e \leq 50/\sqrt{F}$	$50/\sqrt{F} < \lambda_e \leq 90/\sqrt{F}$	$\lambda_e \geq 200/\sqrt{F}$	$90/\sqrt{F} < \lambda_e < 200/\sqrt{F}$
λ_e : effective slenderness ratio of bracing F : Standard strength of bracing			

Table 13-2 (4)

∵ CLASS OF COLUMN AND GIRDER				FA	FB	FC	FD
MEMBER	SECTION	POSITION	CLASS	Width thickness ratios			
COLUMN	H	FLANGE	SS41	9.5	12	15.5	Others
			SM50	8	10	13.2	
		WEB	SS41	43	45	48	
			SM50	37	39	41	
	□		SS41	33	37	48	
			SM50	27	32	41	
	○		SS41	50	70	100	
			SM50	36	50	73	
GIRDER	H	FLANGE	SS41	9	11	15.5	
			SM50	7.5	9.5	13.2	
		WEB	SS41	60	65	71	
			SM50	51	55	61	

Table

Ratios of rigidity R_s	F_s
$0.6 \leq R_s$	1.0
$0.3 < R_s < 0.6$	linear interpolation between 1.0 and 1.5
$R_s \leq 0.3$	1.5

Table

Eccentricity R_e	F_e
$R_e \leq 0.15$	1.0
$0.15 < R_e < 0.3$	linear interpolation between 1.0 and 1.5
$0.3 \leq R_e$	1.5

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The result of calculation for Potential horizontal bearing strength (t)

Frame	Roof FL	5TH FL	4TH FL	OPE FL	MEZ FL	REMARKS
101	136.6	291.6	187.1	329.7	435.8	
102	136.6	—	148.3	240.8	334.9	
103	136.6	307.9	230.8	244.4	187.3	
104	104.1	307.9	212.1	151.4	—	
105	104.1	—	212.1	151.4	—	
106	136.6	262.9	180.0	334.6	378.9	
107	151.6	273.4	—	107.7	334.9	
108	151.6	—	235.5	431.7	335.0	
201	151.6	—	235.5	431.7	335.0	
202	151.6	273.4	—	107.7	334.9	
203	136.6	262.9	180.0	334.6	378.9	
204	104.1	—	212.1	151.4	—	
205	104.1	307.9	212.1	151.4	—	
206	136.6	307.9	230.8	244.4	187.3	
207	136.6	—	148.3	240.8	334.9	
208	136.6	291.6	187.1	329.7	435.8	
Total	2,115.6	2,887.4	2,811.8	3,983.4	4,013.6	
A	464.0	532.6	675.0	649.2	746.0	
B	—	—	—	335.6	722.4	
D	—	—	—	—	—	
F	—	—	—	513.2	715.6	
G	464.0	—	—	—	1,321.2	
H	—	702.0	945.4	786.8	1,079.2	
K	—	336.8	533.0	477.4	253.2	
Total	928.0	1,571.4	2,153.4	2,762.2	4,837.6	

FORM 04

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4) Calculation of required potential horizontal bearing strength and check of potential horizontal bearing strength.

Direction	FL	Ds	Fes	Required potential horizontal bearing strength					Qp (t)	Judgment
				Wi (t)	Ai	C_i	Qud (t)	Qun (t)		
Short span	Roof	0.3	1.5	1,638.4	2.04	1.02	1,671.2	752.0	2,115.6	OK
	5TH	0.4	1.0	3,605.6	1.63	0.82	2,956.6	1,182.6	2,887.4	OK
	4TH	0.4	1.0	5,534.1	1.45	0.73	4,039.9	1,616.0	2,811.8	OK
	OPE	0.4	1.0	9,779.7	1.20	0.60	5,867.8	2,347.1	3,983.4	OK
	MEZ	0.4	1.0	14,581.5	1.00	0.50	7,290.8	2,916.3	4,837.6	OK
Long span	Roof	0.4	1.0	1,638.4	2.22	1.11	1,818.6	727.4	928.0	OK
	5TH	0.4	1.0	3,605.6	1.74	0.87	3,136.9	1,254.8	1,571.4	OK
	4TH	0.4	1.0	5,534.1	1.52	0.76	4,205.9	1,682.4	2,153.4	OK
	OPE	0.4	1.0	9,779.7	1.23	0.62	6,063.4	2,425.4	2,762.2	OK
	MEZ	0.4	1.0	14,581.5	1.00	0.50	7,290.8	2,916.3	3,551.6	OK

The result of calculation for Potential horizontal bearing strength (t) UNIT-1 only

Frame	Roof FL	5TH FL	4TH FL	OPE FL	MEZ FL	REMARKS
101	136.6	291.6	187.1	329.7	435.8	
102	136.6	—	148.3	240.8	334.9	
103	136.6	307.9	230.8	244.4	187.3	
104	104.1	307.9	212.1	151.4	—	
105	104.1	—	212.1	151.4	—	
106	136.6	262.9	180.0	334.6	378.9	
107	151.6	273.4	—	107.7	334.9	
108	151.6	—	235.5	431.7	335.0	
201	151.6	—	235.5	431.7	335.0	
202		273.4				
203		262.9	180.0	246.0	191.6	
204						
205						
206						
207						
208						
Total	1,209.4	1,980.0	1,821.4	2,669.4	2,533.4	
A	232.0	266.3	340.5	324.6	373.0	
B	—	—	—	167.8	361.2	
D	—	—	—	—	—	
F	—	—	—	256.6	357.8	
G	232.0	—	—	—	988.0	
H	—	516.2	702.4	557.8	826.0	
K	—	336.8	533.0	477.4	253.2	
Total	464.0	1,119.3	1,575.9	1,784.2	3,159.2	

FORM 04

4) Calculation of required potential horizontal bearing strength and check of potential horizontal bearing strength.

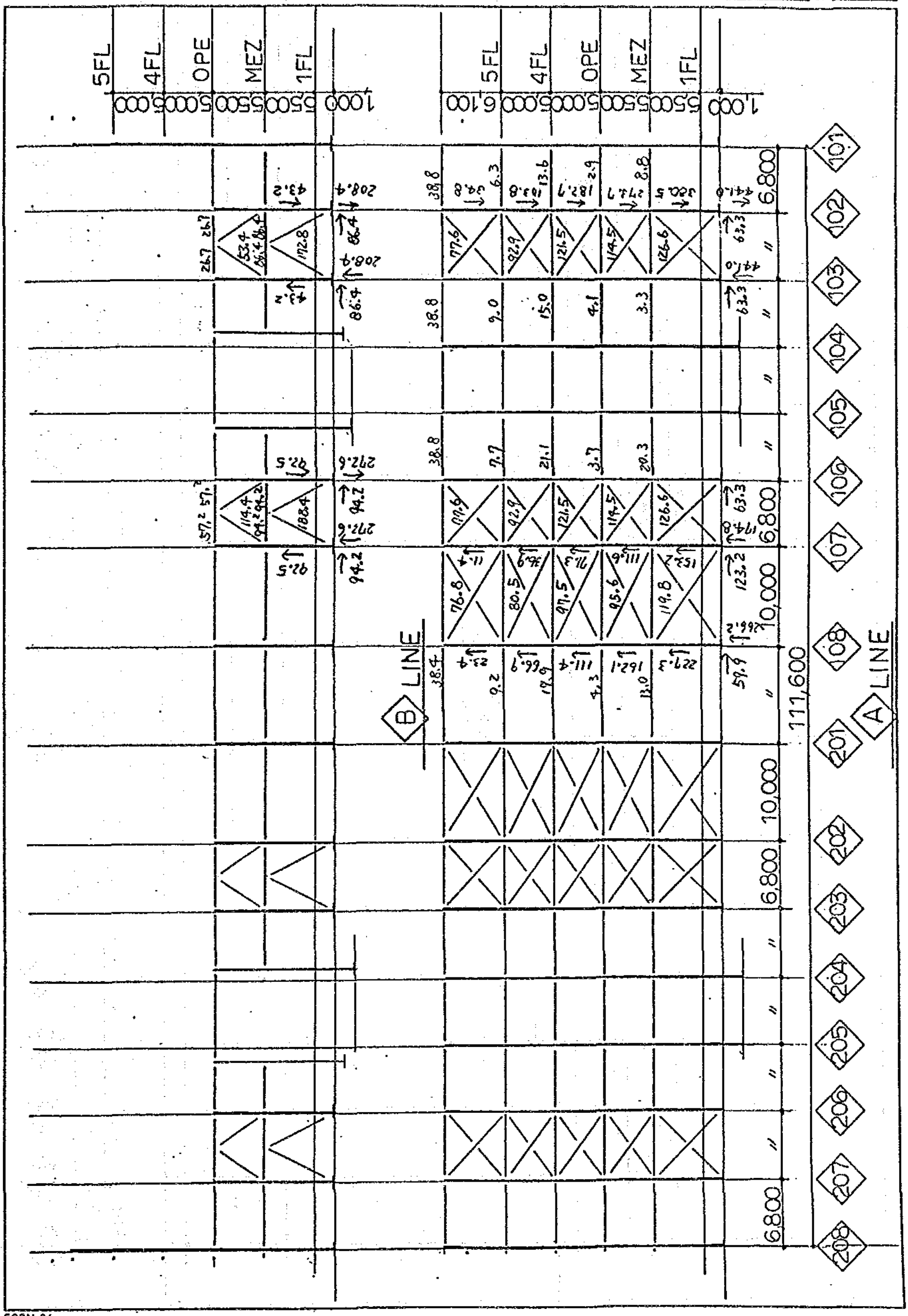
UNIT-1 only

Direction	FL	Ds	Fes	Required potential horizontal bearing strength					Qp	Judgment
				Wi (t)	Ai	Ci	Qud (t)	Qun (t)	(t)	
Short span	Roof	0.3	1.5	972.8	2.10	1.05	1,021.4	459.6	1,209.4	OK
	5TH	0.4	1.0	2,353.2	1.67	0.84	1,976.7	790.7	1,980.0	OK
	4TH	0.4	1.43	3,958.2	1.43	0.72	2,849.9	1,630.1	1,821.4	OK
	OPE	0.4	1.18	6,958.1	1.19	0.60	4,174.9	1,970.6	2,669.4	OK
	MEZ	0.4	1.23	10,193.5	1.00	0.5	5,096.8	2,507.6	2,533.4	OK
Long span	Roof	0.4	1.0	972.8	2.29	1.15	1,118.7	447.5	464.0	OK
	5TH	0.4	1.22	2,353.2	1.78	0.89	2,094.3	1,022.0	1,119.3	OK
	4TH	0.4	1.0	3,958.2	1.51	0.76	3,008.2	1,203.3	1,575.9	OK
	OPE	0.4	1.0	6,958.1	1.22	0.61	4,244.4	1,697.8	1,784.2	OK
	MEZ	0.4	1.41	10,193.5	1.00	0.5	5,096.8	2,874.6	3,159.2	OK

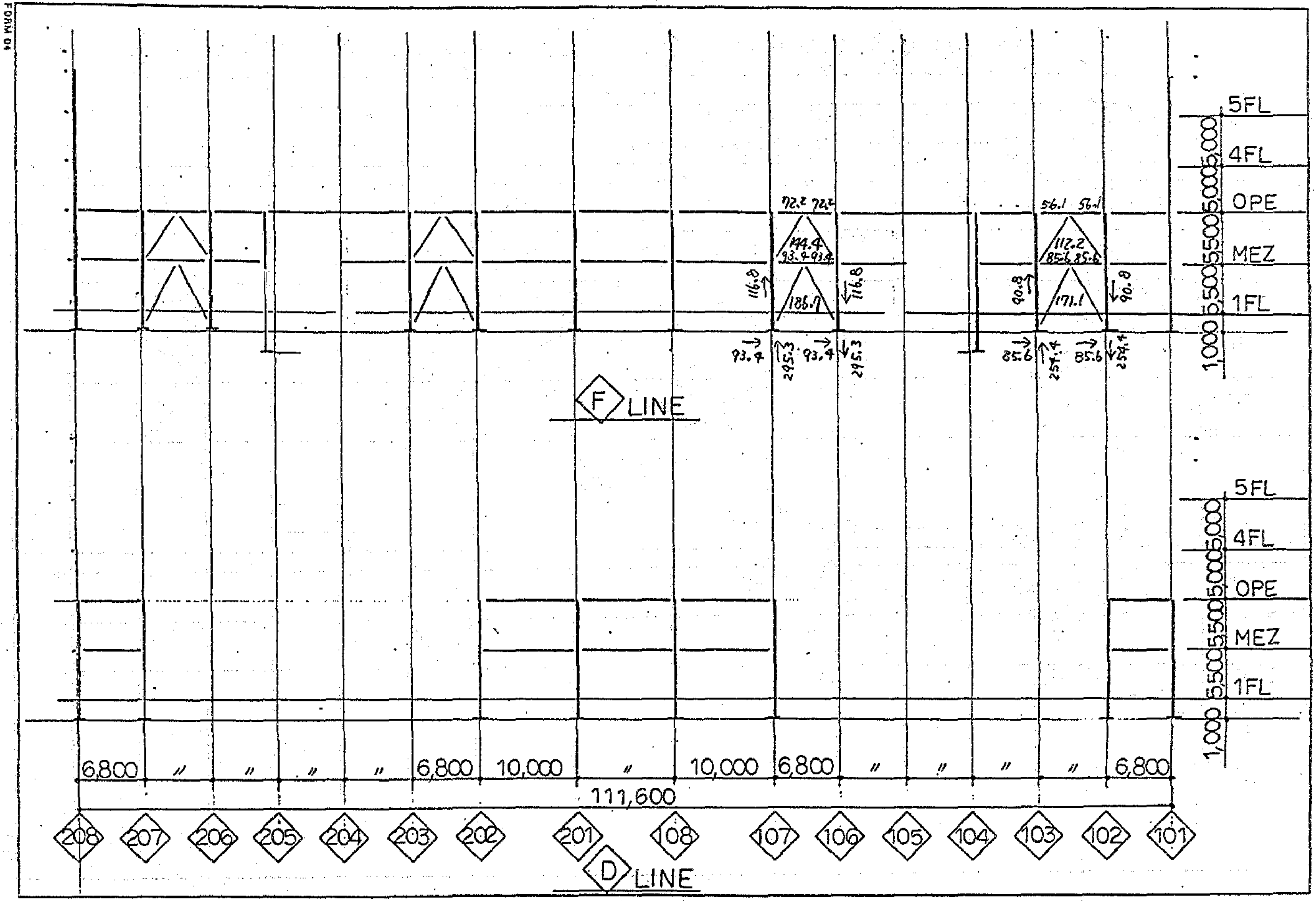
10-3 Check of Girders and Columns

The section of girders and columns shall be checked by the additional axial forces which were calculated by the bearing axial strength of vertical bracings of the potential horizontal bearing strength.

SHEET 265 OF



FORM 04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186.7
116.8
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112.2
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206
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202
201
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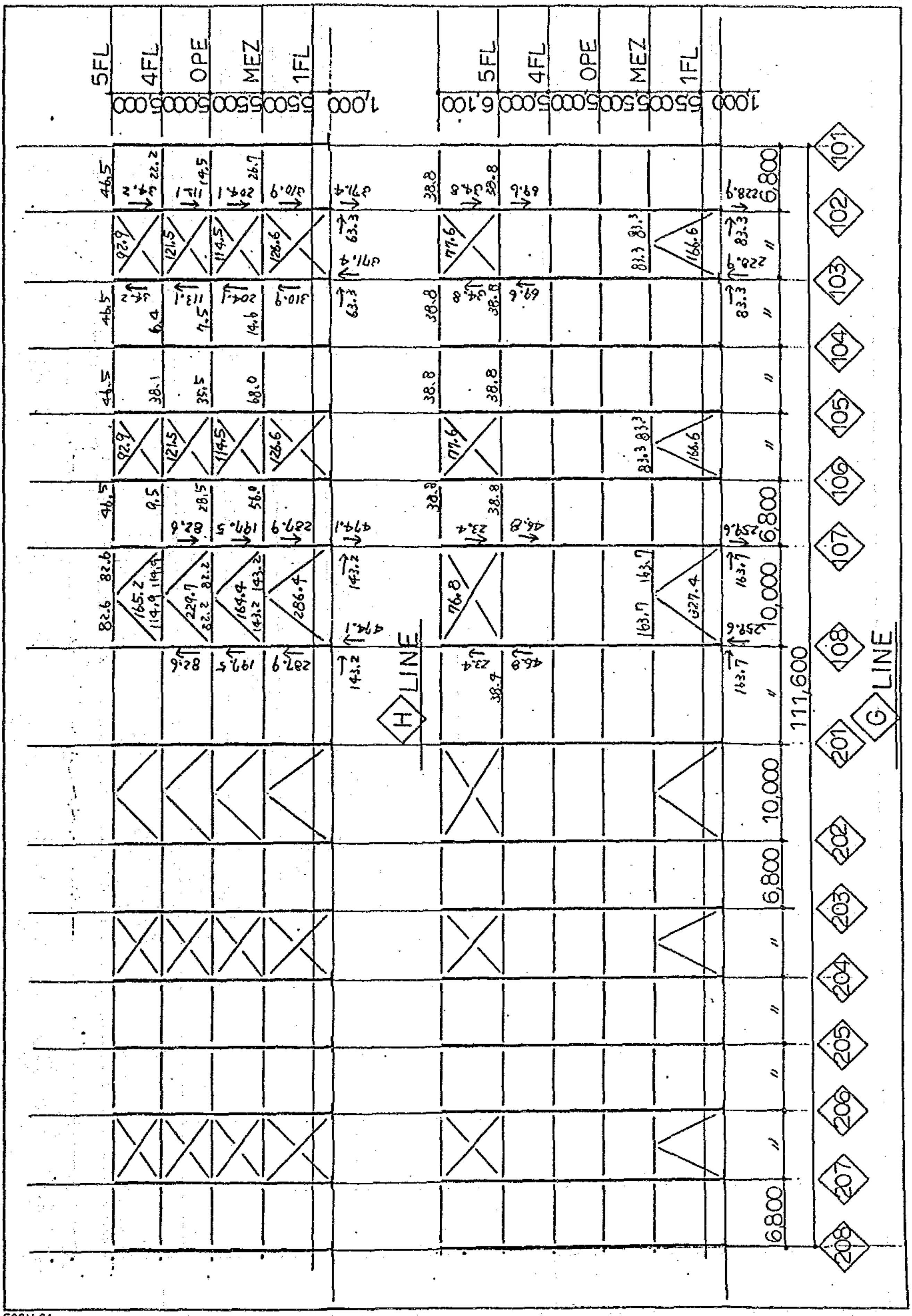
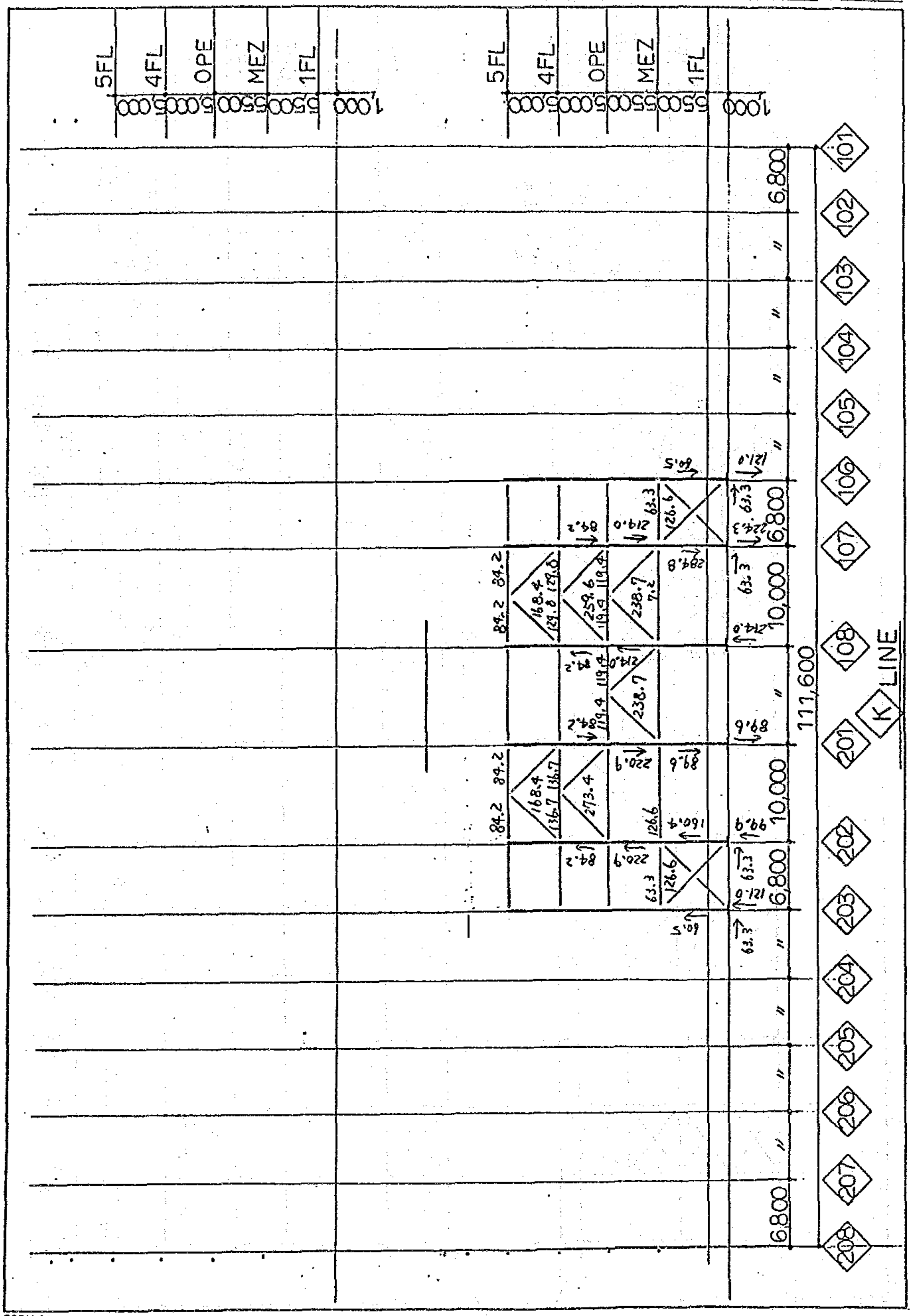
107
106
105
104
103
102
101
D LINE

269

SHEET 267 OF



FORM 04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OPE
MEZ
1FL
K LINE
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102
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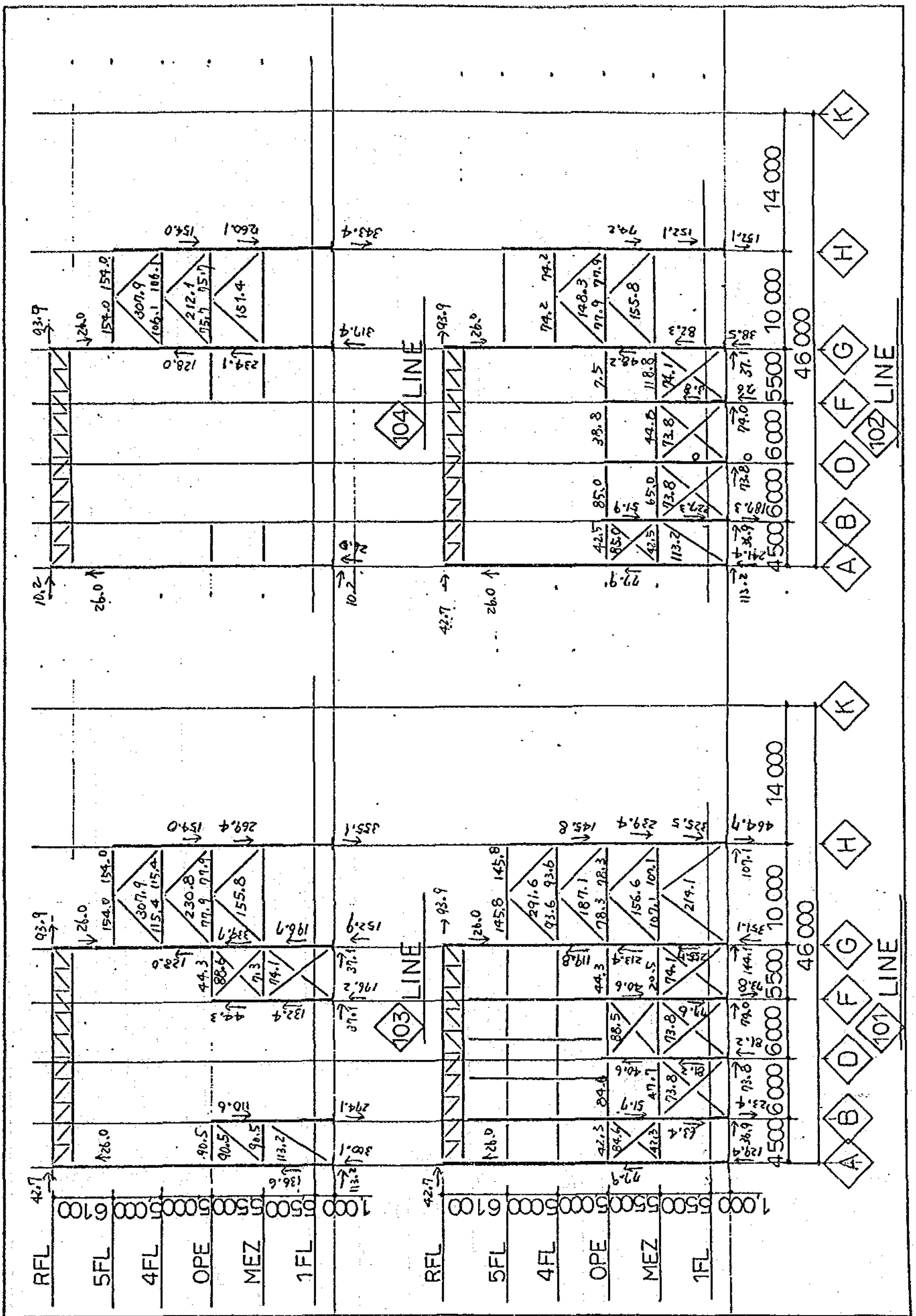
FORM 04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G
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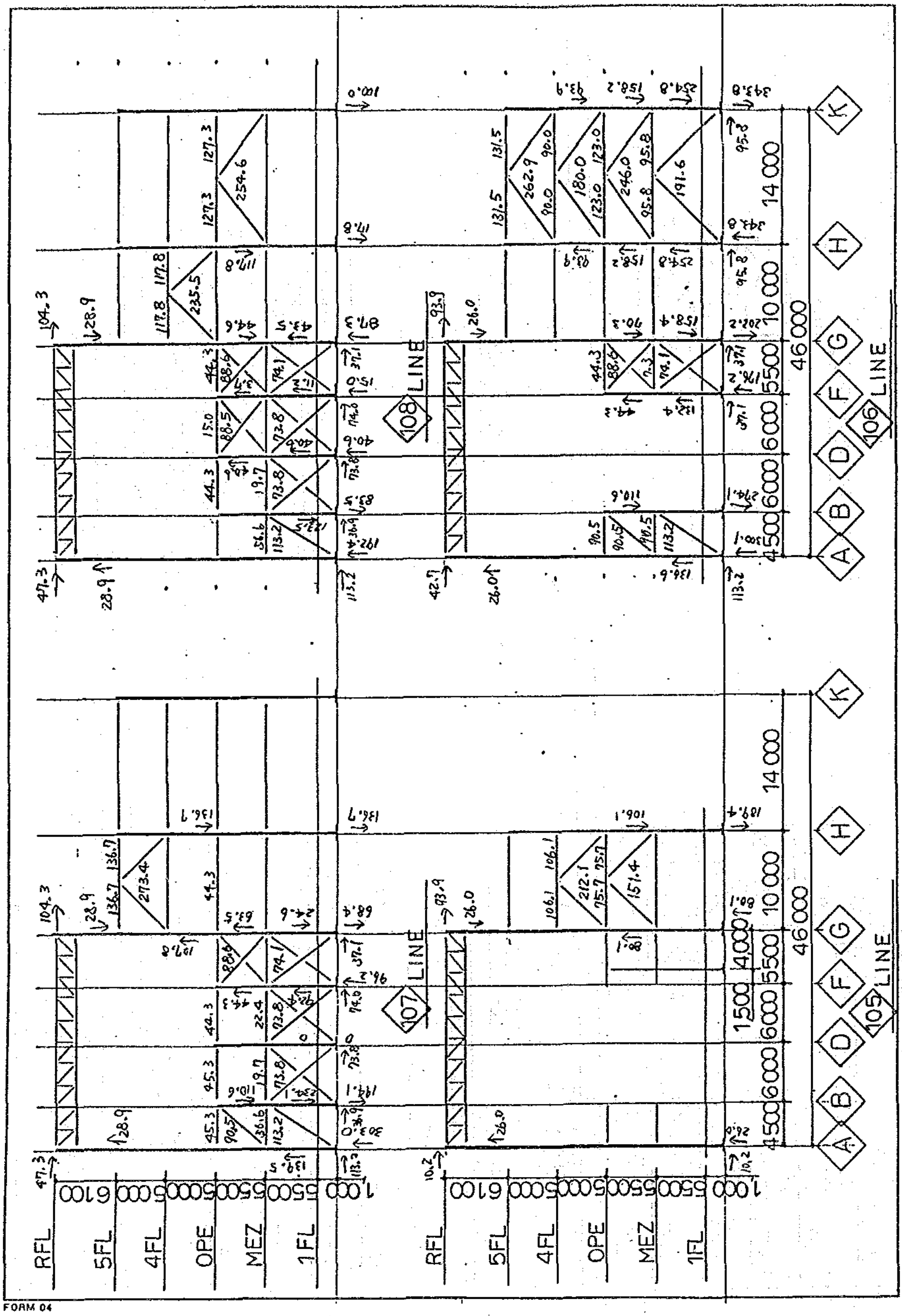
RFL
5FL
4FL
OPE
MEZ
1FL
6100
5000
5000
5500
6500
1,000

FORM 04

SHEET 270 OF



FORM 04

CHECK OF MEMBER (1)
COLUMN

X-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$

$N_Y = A \sigma_Y$

$N_{wY} = A_w \sigma_Y$

LOCATION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{pY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / $\frac{N}{N_Y}$	M_p / $\frac{A_w}{2A}$	M_{pc} / M / $\frac{M}{M_{pc}}$	
A-106	RF				BH-700X350X28/40	453.6	7.95	54	2.20	997.9	286.3	231.7	
					430		9.4	45	2.4				
	Y	(231.7)		79.7	430	11930		173.6		0.29	0.19		
	MEZ				BH-900X350X28X40	509.6	7.51	86	1.91	973.3			
					650		9.15		2.4				
	X			530.8	650		2507			0.55			
					Ditto	509.6	7.51	86	1.91	973.3	401.9	311.6	
					650		9.15	71	2.4				
	Y	30.3		310.7	650	16746		229.6		0.32	0.23	0.10	
A-107	RF				BH-700X400X28X40	493.6	9.31	46	2.26	1115.5	318.0	318.0	
					430		10.85	39	2.4				
	Y	(318.0)		106.2	430	13,250		173.6		0.10	0.18		
	OPE				BH-900X400X28X40	549.6	8.83	62	2.14	1176.1	443.2	443.2	
					550		10.58	51	2.4				
	Y	161.5		186.3	550	18,466		229.6		0.16	0.21	0.36	
	MEZ				Ditto		8.83	73	2.04	1121.2	443.2	443.2	
					650		10.58	61	2.4				
	Y	17.5		239.4	650					0.21	0.21	0.04	
G-103	RF				BH-700X350X28X40	453.6	7.95	54	2.20	997.9	286.3	286.3	
					430		9.4	45	2.4				
	Y	(286.3)		79.3	430	11930				0.08	0.19		
	5TH				BH-900X350X28X40	509.6	7.51	66	2.11	1075.2	401.9	401.9	
					500		9.15	54	2.4				
	Y	140.5		190.0	500	16746				0.18	0.23	0.35	
	MEZ				BH-900X350X28X40		7.51	86	1.91	973.3	401.9	183.3	
					650		9.15	71	2.4				
	Y	2.8		580.9	650					0.60	0.23	0.02	
G-108	RF				BH-700X400X28X40	493.6	9.31	46	2.26	1115.5	318.0	318.0	
					430		10.85	39	2.4				
	Y	(318.0)		105.6	430	13,250		173.6		0.09	0.18		
	5TH				BH-900X400X28X40	549.6	8.83	56	2.19	1203.6	443.2	443.2	
					500		10.58	47	2.4				
	Y	154.8		149.5	500	18466				0.12	0.23	0.35	
	MEZ				BH-900X400X28X40		8.83	73	2.04	1121.2	443.2	272.8	
					650		10.58	61	2.4				
	Y	8.9		520.9	650					0.46	0.21	0.03	

CHECK OF MEMBER (2)

COLUMN

X-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$

$N_Y = A \sigma_Y$

$N_{wY} = A_w \sigma_Y$

LOCATION	DIR	M_ℓ / M_e / M_s	Q_ℓ / Q_e / Q_s	N_ℓ / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{pX}	i_{min} / i / Z_{pY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / N_Y	M_p / A_w / A	M_{pc} / M / M_{pc}	
	MEZ				H-300²	119.8	7.51	87	1.90	227.6			
					650								
B-101	Y			149.8	650	1500				0.66			
	MEZ				※1 H-350²	173.9	8.84	62	2.14	372.1			
					(550)								
B-106	Y			370.4	(550)					0.99			
	MEZ				H-350²				2.14	372.1			
					(550)								
B-102	Y			352.6	(550)					0.95			
	MEZ				H-300²	119.8	7.51	87	1.90	227.6			
					650								
D-101	Y			170.5	650					0.75			
	MEZ				H-350²	173.9	8.84	73	2.04	354.8			
					650								
D-108	Y			239.1	650					0.67			
	MEZ				H-300²	119.8	7.51	73	2.04	244.4			
					(550)								
F-103	Y			236.3	(550)					0.97			
	MEZ				H-350²	173.9	8.84	73	2.04	354.8			
F-107	Y			253.0	650					0.71			
	4TH				※1 H-390	136.0	7.28	69	2.08	282.9			
H-101	Y			188.6	500					0.67			
	MEZ				※1 H-400²	218.7	10.1	64	2.13	465.8			
	Y			405	650					0.87			
	MEZ				H-400²					465.8			
H-102	Y			359.4	650					0.77			
	4TH				H-440	157.4	7.18	70	2.07	325.8			
H-103	Y			314.9	500					0.97			
	MEZ				BH-450²	289.0	11.46	48	2.25	650.3			
	Y			636	(550)					0.98			

FORM 04

CHECK OF MEMBER (3)

COLUMN

X-AXIS: $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$; $\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS: $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$; $\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$ $N_Y = A \sigma_Y$ $N_{wY} = A_w \sigma_Y$

LOCATION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{pY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / N_Y	M_p / A_w / A	M_{pc} / M / M_{pc}
	4TH				BH-480x350x16x22	223.76	8.38	59	2.17	485.6		
H-108	X			322.0	500					0.66		
	MEZ				BH-516x500x22x40	495.92	12.97	50	2.23	1105.9		
	X			881.0	650					0.80		
	4TH				※H-390	136.0	7.28	69	2.08	282.9		
(K-106)												
K-203	Y			149.2	500					0.53		
	MEZ				※H-400²	218.7	10.1	64	2.13	465.8		
	Y			433.7	650					0.93		
	4TH				H-440	157.4	7.18	70	2.07	325.8		
K-107	X			217.9	500					0.67		
	MEZ				BH-450²	289.0	11.46	57	2.18	630.0		
	X			572.9	650					0.91		

CHECK OF MEMBER (1)
GIRDER

X-AXIS
$$\frac{N}{N_Y} \leq \frac{A_w}{2A} \quad M_{pc} = M_p$$
$$\frac{N}{N_Y} > \frac{A_w}{2A} \quad M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$$

Y-AXIS
$$\frac{N}{N_Y} \leq \frac{A_w}{A} \quad M_{pc} = M_p$$
$$\frac{N}{N_Y} > \frac{A_w}{A} \quad M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$$

$M_p = Z_p \sigma_Y$
$N_Y = A \sigma_Y$
$N_{wY} = A_w \sigma_Y$

LOCA-TION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{pY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / $\frac{N}{N_Y}$	M_p / $\frac{A_w}{2A}$	M_{pc} / M / $\frac{M}{M_{pc}}$
RFL		5.3	3.1		H-350	63.14	3.95	86	1.9	120.0	20.8	16.1
				38.8					2.4			
A,G LINE	101~107				340	868		22.96		0.32	0.18	0.33
		11.4	11.4		H-400	84.12	4.54	110	1.59	133.8	31.9	25.8
				38.9					2.4			
	107~202				500	1330		29.9		0.29	0.17	0.44
5TH		23.3	9.5		H-500	119.2	4.33	91	1.05	211.3	52.3	52.3
				38.8					2.4			
G LINE	101~102				395	2180		46.8		0.18	0.20	0.45
		11.1	4.5		H-400	84.12	4.54	110	1.59	133.8	31.9	30.1
				38.4					2.4			
	102~202				500	1330		29.9		0.29	0.17	0.37
		8.9	5.2		H-488	163.5	7.04	97	1.77	289.4	77.5	74.2
				46.5	680		7.97	21	2.4			
H LINE	103~105				680	3230		49.72		0.16	0.15	0.12
		19.1	19.1		H-488	163.5	7.04	71	2.06	336.8	77.5	66.3
				82.6	500		7.97	63	2.4			
	107~108				500	3230		49.72		0.25	0.15	0.29
		7.5	7.5		H-488	163.5	7.04	71	2.06	336.8	77.5	50.4
				145.8	500		7.97	63	2.4			
101 LINE	G~H				500	3230		49.72		0.43	0.15	0.15
		74.7		4.6	H-800	267.4	6.62	30	2.34	625.7	197.8	169.1
103				154.0	200		7.80	26	2.4			
104 LINE	G-H			158.6	200	8240		104.72		0.25	0.20	0.44
		17.8			H-488	163.5	7.04	100	1.73	282.9	68.8	42.4
				131.5	700		7.97	88	2.13			
106 LINE	H-K				700	3230		49.72		0.46	0.15	0.42
		16.6			H-488	163.5	7.04	28	2.35	384.2	77.5	56.5
				136.7					2.4			
107 LINE	G-H				200	3230		49.72		0.36	0.15	0.29
4TH		0.3			H-294	72.38	4.71	144	1.0	72.4	13.9	11.3
				21.1			5.32	128	1.62			
A LINE	101-107				680	859		21.6		0.29	0.15	0.03
		0.6			H-250²	92.18	6.29	159	0.82	75.6	18.1	15.3
				19.9			6.87	146	1.89			
	107-202				1,000	960		19.98		0.26	0.11	0.04

FORM 04

CHECK OF MEMBER (2)

GIRDER

X-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$

$N_Y = A \sigma_Y$

$N_{wY} = A_w \sigma_Y$

LOCATION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{pY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / $\frac{N}{N_Y}$	M_p / $\frac{A_w}{A}$	M_{pc} / $\frac{M}{M_{pc}}$	
		18.9			H-500	114.2	4.33	91	1.85	211.3	52.3	52.3	
				22.2	285		5.14	55	2.4				
H LINE	101-102				395	2180		46.8		0.11	0.20	0.36	
		11.0			H-488	163.5	7.04	97	1.77	289.4	71.1	71.1	
				38.1			7.97	85	2.20				
	103~105				680	3230		49.72		0.13	0.15	0.15	
		38.4			H-488	163.5	7.04	36	2.31	377.7	71.1	56.7	
				114.9					2.40				
	107-108				250	3230		49.72		0.30	0.15	0.68	
		16.6			H-488	163.5	7.04	36	2.31	377.2	71.1	51.9	
				136.7	250		7.97	31	2.4				
K LINE	201-202				250	3230		49.72		0.36	0.15	0.32	
		8.1			H-488	163.5	7.04	71	2.06	336.8	71.1	58.4	
				93.6	500		7.97	63	2.4				
101 LINE	G-H				500	3230		49.72		0.28	0.15	0.14	
		28.2			H-488	163.5	7.04	28	2.35	384.2	71.1	65.7	
				79.2	200		7.97	25	2.4				
102 LINE	G-H				200	3230		49.72		0.19	0.15	0.43	
		38.5			H-488	163.5	7.04	28	2.35	384.2	71.1	56.7	
				115.4	200		7.97	25	2.4				
103 LINE	G-H				200	3230		49.72		0.30	0.15	0.68	
		9.2			H-488			99	1.74	284.5	68.8	53.3	
				90.0	700			88	2.13				
106 LINE	H-K				700					0.32	0.15	0.17	
		35.6			H-488			28	2.35	384.2	71.1	55.9	
				117.8	200			25	2.4				
108 LINE	G-H				200					0.31	0.15	0.64	
OPE		39.3			H-488		7.04	32	2.33	381.0	71.1	71.1	
				3.7					2.4				
A LINE	105-106				227					0.01	0.15	0.55	
		26.6			H-488				2.33	381.0	71.1	71.1	
				56.1					2.4				
F LINE	102-103				227					0.15	0.15	0.37	
		11.3			H-488		7.04	32	2.33	381.0	71.1	65.7	
				72.2	227		7.97	28	2.4				
	106-107				227					0.19	0.15	0.17	

CHECK OF MEMBER (3)
GIRDER

X-AXIS: $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$; $\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS: $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$; $\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wY}}{N_Y - N_{wY}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$, $N_Y = A \sigma_Y$, $N_{wY} = A_w \sigma_Y$

LOCATION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{PY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / N_Y	M_P / A_w / $2A$	M_{pc} / M / M_{pc}
		1.7			H-500	114.2	4.33	157	0.84	95.9	27.7	19.9
				35.5	680		5.14	132	1.27			
H LINE	104-105				680	2180		46.8		0.37	0.20	0.09
		64.7			H-700	235.5	6.78	29	2.34	551.1	155.0	155.0
				82.2	200		7.87	25	2.4			
	107-108				200	6460		84.76		0.15	0.18	0.42
		23.8			H-488	163.5	7.04	28	2.35	384.2	71.1	55.9
				119.4	200		7.97	29	2.4			
K LINE	107-108				200	3230		49.72		0.31	0.15	0.43
		8.6			H-350	63.14	3.95	86	1.9	120.0	20.8	15.9
				42.3					2.4			
101 LINE	A-B				450	868		22.96		0.35	0.18	0.56
		25.5			※ H-488	163.5	7.04	85	1.92	313.9	71.1	59.2
				84.6					2.4			
	B-D				600	3230		49.72		0.27	0.15	0.43
		8.3			H-500	114.2	4.33	80	1.97	225.0	52.3	52.3
				44.3	350		5.14	68	2.4			
	F-G				350	2180		46.8		0.20	0.20	0.16
		5.1			H-488	163.5	7.04	71	2.06	336.8	72.5	68.0
				78.3	500		7.97	62	2.4			
	G-H				500	3230		49.72		0.23	0.15	0.07
		16.5			H-450	96.76	4.40	102	1.71	165.5	40.3	34.0
				42.5					2.4			
102 LINE	A-B				450	1680		37.98		0.26	0.24	0.49
		65.0			H-700	235.5	6.78	59	2.17	511.0	155.0	155.0
				85.0					2.4			
	B-D				400	6460		84.76		0.17	0.18	0.42
		16.5			H-450	96.76	4.40	102	1.71	165.5	40.3	20.7
				90.5					2.4			
103 LINE	A-B				450	1680				0.55	0.24	0.80
		13.6			H-450	96.76	4.40	125	1.33	128.7	40.3	30.3
				44.3					2.4			
	F-G				550					0.34	0.24	0.45
		29.6			H-500	114.2	4.33	127	1.29	147.3	52.3	41.7
				44.3					2.4			
106 LINE	F-G				550	2180				0.30	0.20	0.59

CHECK OF MEMBER (4)

GIRDER

X-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{PC} = M_P$

$\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{PC} = 1.14\left(1 - \frac{N}{N_Y}\right) M_P$

Y-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{PC} = M_P$

$\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{PC} = \left\{1 - \left(\frac{N - N_{WY}}{N_Y - N_{WY}}\right)^2\right\} M_P$

$M_P = Z_P \sigma_Y$

$N_Y = A \sigma_Y$

$N_{WY} = A_w \sigma_Y$

LOCATION	DIR	M_J / M_e / M_s	Q_ℓ / Q_e / Q_s	N_ℓ / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{PX}	i_{min} / i / Z_{PY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N / N_Y	M_P / A_w / $2A$	M_{PC} / M / M_{PC}
		14.0			H-488	163.5	7.04	78	1.99	325.4	77.5	54.8
				123.0	550		7.97	69	2.4			
106 LINE	H-K				550	3230		49.72		0.38	0.15	0.26
		12.6			H-400	84.12	4.54	132	1.19	100.1	31.9	20.0
				45.3					2.4			
107 LINE	B-F				600	1330		29.9		0.45	0.17	0.63
		17.8			H-450	96.76	4.40	125	1.33	128.7	40.3	30.3
				44.3					2.4			
108 LINE	F-G				550	1680		37.98		0.36	0.24	0.59
		12.3			H-488	163.5	7.04	99	1.75	286.1	68.8	43.9
				127.3	700		7.97	88	2.13			
	H-K				700	3230				0.44	0.15	0.28
ME8		30.6			H-600	134.4	4.12	55	2.20	295.7	71.5	71.5
				8.8					2.4			
A LINE	101-102				227	2980		62.26		0.03	0.23	0.43
		45.0			H-588	192.5	6.85	33	2.33	448.5	107.8	107.8
				20.3					2.4			
	105-106				227	4490		65.76		0.05	0.17	0.42
		14.1			H-488	163.5	7.04	32	2.33	381.0	77.5	68.0
				86.4	227		7.97	28	2.4			
B LINE	102-103				227	3230				0.23	0.15	0.21
		5.3			H-488				2.33	381.0	77.5	66.3
				94.2	227				2.4			
	106-107				227					0.25	0.15	0.08
		19.5			H-488				2.33	381.0	77.5	68.9
				83.3	227				2.4			
G LINE	102-103				227					0.22	0.15	0.28
		39.4			H-488		7.04	28	2.35	384.2	77.5	50.4
				163.7	200		7.97	25	2.4			
	107-108				200					0.43	0.15	0.78
		37.6			H-588	192.5	6.85	42	2.28	438.9	107.8	107.8
				26.7	285		7.87	36	2.4			
H LINE	101-102				285	4490				0.06	0.17	0.35
		9.2			H-700	235.5	6.78	100	1.73	407.4	131.8	131.8
				68.0	680		7.87	86	2.04			
	104-105				680	6460				0.17	0.18	0.07

CHECK OF MEMBER (5)
GIRDER

X-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{2A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{2A}$ $M_{pc} = 1.14\left(1 - \frac{N}{N_Y}\right) M_p$

Y-AXIS $\frac{N}{N_Y} \leq \frac{A_w}{A}$ $M_{pc} = M_p$

$\frac{N}{N_Y} > \frac{A_w}{A}$ $M_{pc} = \left\{1 - \left(\frac{N - N_{wy}}{N_Y - N_{wy}}\right)^2\right\} M_p$

$M_p = Z_p \sigma_Y$ $N_Y = A \sigma_Y$ $N_{wy} = A_w \sigma_Y$

LOCATION	DIR	M_l / M_e / M_s	Q_l / Q_e / Q_s	N_l / N_e / N_s	MEMBER / l_b / l_k	A / I / Z_{px}	i_{min} / i / Z_{PY}	λ_k / λ_b / A_w	f_c / f_b / f_s	N_Y / N/N_Y	M_p / A_w/2A	M_{pc} / M/M_{pc}	
		115.1			H-900	309.8	6.39	36	2.31	715.6	252.0	252.0	
				56.0					2.4				
H-LINE	106-107				227	10500		135.04		0.08	0.22	0.46	
		65.9			H-700	235.5	6.78	29	2.34	551.1	155.0	130.8	
				143.2					2.4				
	107-108				200	6460				0.26	0.18	0.50	
		59.0			H-700		6.78	33	2.33	548.7	155.0	155.0	
				63.3					2.4				
K LINE	106-107				227					0.12	0.18	0.38	
		98.8			H-800	262.4	6.62	30	2.34	625.7	197.8	180.4	
				126.6					2.4				
	201-202				200	8240		104.72		0.20	0.20	0.55	
		45.7			H-588	192.5	6.85	33	2.33	448.5	107.8	107.8	
				63.3					2.4				
	202-203				227	4490				0.14	0.17	0.42	
		8.9			H-400	84.12	4.54	99	1.75	147.2	31.9	25.8	
				47.3					2.4				
101 LINE	A-B				450	1330				0.29	0.17	0.34	
		15.8			H-600	134.4	4.12	146	0.97	130.4	71.5	51.4	
				47.7					2.4				
	B-D				600	2980		62.26		0.37	0.23	0.31	
		8.0			H-588	192.5	6.85	73	2.04	392.7	107.8	89.7	
				107.1	500		7.87	64	2.4				
	G-H				500	4490				0.27	0.17	0.09	
		14.0			H-488	163.5	7.04	78	1.99	325.4	77.5	55.7	
				118.8					2.4				
102 LINE	F-G				550	3230				0.37	0.15	0.25	
		8.9			H-400	84.12	4.54	99	1.75	147.2	31.9	14.2	
				90.5					2.4				
103 LINE	A-B				450	1330				0.61	0.17	0.63	
		19.5			H-588	192.5	6.85	102	1.71	329.2	84.0	68.0	
				95.8	700		7.87	89	1.87				
106 LINE	H-K				700	4490				0.29	0.17	0.29	
		3.3			H-350	63.14	3.95	114	1.53	96.6	20.8	9.7	
				56.6					2.4				
108 LINE	A-B				450	868				0.59	0.18	0.34	

TABLE FOR COLUMN BASE (1)
[柱応力表]

NOTE : VL --- VERTICAL LOAD
CDL --- CRANE DEAD LOAD
CLL --- CRANE LIFTING LOAD
SL --- SEISMIC LOAD
CHL --- CRANE HORIZONTAL LOAD
PC --- PERMANENT CONDITIONS (VL+CLL)
TC --- TEMPORARY CONDITIONS (VL+CDL+CHL+SL)

LOCA-TION	DIR	LEV.	VL			CDL			CLL			SL			CHL			PC			TC			REMARKS
			N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	
A-101 208	Y		96.8			23.3		-0.2				-129.4		0.0	0.1		0.3				-32.6 226.2			)Y
102 207	X Y		142.4			23.3		-0.2				441.0 -241.4		63.3 113.2	0.1		0.3				-298.6 606.7		63.3 63.4	)X
103 206	X Y		142.4			24.1		-0.1				-441.0 -300.1		63.3 113.2	0.1		0.3				-157.7		113.2	)Y
104 205	Y		106.5			24.9		-0.3				-26.0		10.2	0.7		0.5							
105 204	Y		107.5			24.9		-0.3				-26.0		10.2	0.7		0.5							
106 203	X Y		150.3			24.1		-0.1				441.0 -300.1		63.3 113.2	0.1		0.3				615.4		63.3	X
107 202	X Y		173.5			28.3		0.0				-179.8 -303.0		123.2 113.2	0.3		0.4				-1.3 376.6		123.2 123.2	)X
108 201	X Y		133.1			28.3		0.0				-266.2 -192.4		59.9 113.2	0.3		0.4				-129.5 504.8		113.2 113.2	)Y
B-101 208			86.4			1.4		0.0				23.4		36.9	0.1		0.1							
102 207			125.3		11.9	1.4		0.0				208.4 187.3		86.4 36.9	0.1		0.1				-83.1 333.7		-74.5 98.3	)X
103 206			79.4		-11.9	0.9		0.0				-208.4 274.1		86.4	0.2		0.0				-129.0		74.5	X
104 205			35.1																					
105 204			36.1																					
106 203			96.3		11.9	0.9		0.0				272.6 274.1		94.2	0.0		0.0				369.8		106.1	X
107 202			143.6		-11.9	0.0		0.0				-272.6 199.1		94.2 36.9	-0.1		0.1				416.2		106.1	X
108			90.8			0.0		0.0				83.5		36.9	-0.1		0.1							
201			82.8			0.0		0.0				83.5		36.9	-0.1		0.1							

TABLE FOR COLUMN BASE (2)
〔柱応力表〕

NOTE :
VL --- VERTICAL LOAD
CDL --- CRANE DEAD LOAD
CLL --- CRANE LIFTING LOAD
SL --- SEISMIC LOAD
CHL --- CRANE HORIZONTAL LOAD
PC --- PERMANENT CONDITIONS (VL+CLL)
TC --- TEMPORARY CONDITIONS (VL+CDL+CHL+SL)

LOCATION	DIR	LEV.	VL			CDL			CLL			SL			CHL			PC			TC			REMARKS
			N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	N, t	M, tm	Q, t	
D-101 208			89.3			0.2		0.3				-81.2		73.8	0.0		0.1				8.1 / 170.5		73.8	Y
102 207			136.1			0.2		0.3				0		73.8	0.0		0.1				136.1		73.8	Y
107 202			135.1			0.1		0.0				0		73.8	-0.2		0.2							
108			198.5			0.1		0.0				-40.6		73.8	-0.2		0.2				239.1		73.8	Y
201			187.7			0.1		0.0				-40.6		73.8	-0.2		0.2							
F-101 208			81.1			0.4		-0.2				73.8		74.0	0.0		0.1				154.9 / 7.3		74.0 / 74.0	Y
102 207			128.4		11.9	0.4		-0.2				254.4 / -7.6		85.6 / 74.0	0.0		0.1				-126.0 / 382.8		73.7 / 97.5	X
103 206			103.9		-11.9	0.8		-0.2				-254.4 / -176.2		85.6 / 37.1	-0.3		0.1							
104 105 304 305			43.2																					
106			75.4		11.9	0.8		-0.2				254.4 / -176.2		85.6 / 37.1	-0.3		0.1				-179.0		73.7	X
107 202			160.6		-11.9	1.0		-0.2				-254.4 / -96.2		85.6 / 74.0	-0.1		0.1							
108			188.6			1.0		-0.2				-15.0		74.0	-0.1		0.1							
201			179.7			1.0		-0.2				-15.0		74.0	-0.1		0.1							
203			92.6			0.8		-0.2				-254.4 / -176.2		85.6 / 37.1	-0.3		0.1							

TABLE FOR COLUMN BASE (3)
〔柱応力表〕

NOTE :
VL --- VERTICAL LOAD
CDL --- CRANE DEAD LOAD
CLL --- CRANE LIFTING LOAD
SL --- SEISMIC LOAD
CHL --- CRANE HORIZONTAL LOAD
PC --- PERMANENT CONDITIONS (VL+CLL)
TC --- TEMPORARY CONDITIONS (VL+CDL+CHL+SL)

LOCATION	DIR	LEV.	VL N,t	VL M,tm	VL Q,t	CDL N,t	CDL M,tm	CDL Q,t	CLL N,t	CLL M,tm	CLL Q,t	SL N,t	SL M,tm	SL Q,t	CHL N,t	CHL M,tm	CHL Q,t	PC N,t	PC M,tm	PC Q,t	TC N,t	TC M,tm	TC Q,t	REMARKS
G-101																					-170.0		134.4	)Y
208			181.1		-9.7	11.6		0.0				-351.1		144.1	-0.5		0.1				593.8		153.8	
102					15.0							228.9		83.3										
207			300.9			11.6		0.0				-38.5		37.1	-0.5		0.1							
103					-15.0							-228.9		83.3										
206			373.7			10.0		0.1				-152.9		37.1	-0.6		0.0							
104																								
205			365.0			10.8		0.0				-317.4			-1.3		0.0							
105					14.9							228.9		83.3										
204			295.7			10.8		0.0				-80.1			-1.3		0.0							
106					-14.9							-228.9		83.3							94.3		68.4	X
203			273.2			10.0		0.1				202.2		37.1	-0.6		0.0							
107					30.3							259.6		163.7							641.1		194.0	X
202			381.5			12.6		0.1				68.4		37.1	-0.2		0.1							
108					-30.3							-259.6		163.7							724.8		187.6	X
201			465.2			12.6		0.1				-87.3		37.1	-0.2		0.1							
H-101																					-385.2		97.4	)Y
208			79.5		9.7	1.2		0.0				464.7		107.1	0.3		0.0				544.2		116.8	
102												371.4		63.3							-164.1		63.3	X
207			207.3			1.2		0.0				152.1			0.3		0.0							
103												-371.4		63.3							652.3		63.3	X
206			280.9			2.3		0.0				355.1			0.6		0.0							
104																								
205			305.4			2.4		0.0				343.4			0.6		0.0							
105												371.4		63.3										
206			231.8			2.4		0.0				189.9			0.6		0.0							
106												-371.4		63.3							709.8		63.3	X
			338.4		-16.5	2.3		0.0				-393.8		95.8	0.6		0.0				682.2		112.3	Y
107					50.8							474.1		193.2							995.1		194.0	X
202			521.0			1.0		0.0				136.7			0.0		0.0							
108					-50.8							-474.1		193.2							1,062.2		164.2	X
201			593.1			1.0		0.0				17.8			0.0		0.0							
203												371.4		63.3										
			371.8		-15.0	2.3		0.0				-343.8		95.8	0.6		0.0							

TABLE FOR COLUMN BASE (4)
[柱応力表]

NOTE : VL --- VERTICAL LOAD
CDL --- CRANE DEAD LOAD
CLL --- CRANE LIFTING LOAD
SL --- SEISMIC LOAD
CHL--- CRANE HORIZONTAL LOAD
PC --- PERMANENT CONDITIONS (VL+CLL)
TC --- TEMPORARY CONDITIONS (VL+CDL+CHL+SL)

LOCA-TION	DIR	LEV.	VL			CDL			CLL			SL			CHL			PC			TC			REMARKS
			N,t	M,tm	Q,t	N,t	M,tm	Q,t	N,t	M,tm	Q,t	N,t	M,tm	Q,t	N,t	M,tm	Q,t	N,t	M,tm	Q,t	N,t	M,tm	Q,t	
K-106			147.8		16.5	0.2		0.0				121.0 343.8		63.3 95.8	0.3		0.0				-196.0 491.6		79.3 112.3	) Y
107			288.1			0.2		0.0				224.3		63.3	0.3		0.0				512.4		63.3	X
108			303.6			0.2		0.0				-214.0 100.0			0.3		0.0				517.6			X
201			289.8			0.2		0.0				89.6 100.0			0.3		0.0							
202			248.7			0.2		0.0				-99.9		63.3	0.3		0.0							
203			178.9		15.0	0.2		0.0				-121.0 343.8		63.3 95.8	0.3		0.0							

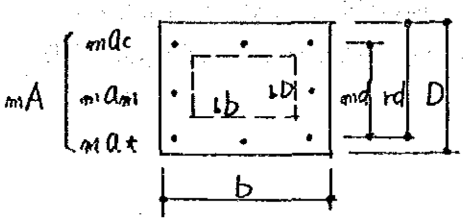
CHECK OF COLUMN BASE (1)
(柱脚の検討)

LOCATION		A-102		G-108　　A-107	
COLUMN SIZE		BH-900×350×28×40		BH-900×400×28×40	
DIRECTION		X	~~Y~~ X	X	Y
LOAD CONDITIONS	M (tm)	31.7	31.7	93.8	
	N (t)	−298.6	606.7	724.8	−129.5
	Q (t)	63.3	63.3	187.6	113.2
FIGURE		TYPE-1A 26−#8　(D25)		TYPE-2A, 2B 26−#8　(D25)	
BASE PLATE	bb × bD	1300×700		1300×700	
ANCHOR BOLT	m − Dφ	8−30φ		8−35φ	
	aA (cm²)	56.55		76.96	
$_cr_u = 0.85 - 2.5\ _sP_c$		0.828		0.825	
REINFORCEMENT	b × D	1600×1000		1600×1000	
	md, rd	900, 950		900, 950	1500, 1550
	$_ma_m$, $_ma_t$, $_mA$ (cm²)	31.78, 35.75, 103.30		31.78, 35.75, 103.30	27.81, 23.83, 103.30
N<0	$_aN_{tu} = {}_aA \cdot {}_a\sigma_Y$	56.55×1.8 = 101.8		76.96×1.8 = 138.5	
	$_mN_u = N + {}_aN_{tu}$	−196.8		8.9 > 0　ok	
	$_mM_u > M$	$0.9\times\{35.75\times3.0+\frac{1}{2}\times(-196.8+31.78\times3.0)\}$			
	$= {}_md\{{}_ma_t\,{}_m\sigma_Y + \frac{1}{2}({}_mN_u + {}_ma_m\,{}_m\sigma_Y)\}$	= 50.8　> 31.7　ok			
N≥0	$_bN_{cu} = {}_bb \cdot {}_bD \cdot 0.85 \cdot F_c$	130×70×0.85×0.21		130×70×0.85×0.21	
	> N	= 1,624 > 606.7　ok		= 1,624 > 724.8　ok	
	$_cM_{cu} = {}_md \cdot {}_ma_t \cdot {}_m\sigma_Y$	0.9×35.75×3.0 = 96.5			
	$_mM_{cu} = (bD^2 - {}_bb \cdot {}_bD^2) F_c\,{}_cr_u / 8$				
	$_cM_{cu} + {}_mM_{cu} > M$	> 31.7 ok		96.5 > 93.8　ok	
Q	$_sQ_u = 0.5N + \frac{3}{4}\,{}_aA \cdot 0.25 \cdot {}_a\sigma_Y$	$\frac{3}{4}$×56.55×0.25×1.8 = 19.1			
	$_rQ_u = (b - {}_bb)\times\frac{7}{8}\,{}_rd \cdot 2F_s$	(160−130)×$\frac{7}{8}$×95×2×0.032 = 159.6			
	$_sQ_u + {}_rQ_u > Q$	178.7　> 63.3　ok			
REMARKS					

NOTATION

$F_s = \min(0.15F_c,\ 22.5 + 4.5F_c/100)$

$_sP_c$ = compression area of steel / bD



FORM 04

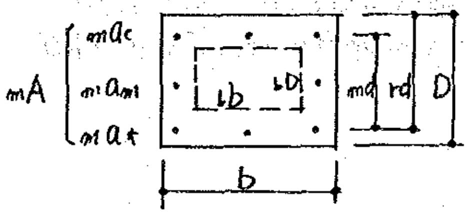
CHECK OF COLUMN BASE (2)
(柱脚の検討)

		D-101		H-101	
LOCATION		D-101		H-101	
COLUMN SIZE		H-300² x 10 x 15		H-400² x 13 x 21	
DIRECTION		X	Y	*Y	Y
LOAD CONDITIONS	M (tm)	22.1		35.0	29.2
	N (t)	170.5 (&1)		544.2	-385.2
	Q (t)	73.8		116.8	97.4
FIGURE		TYPE-3A 14-#8		TYPE-65 24-#8	
BASE PLATE	bb x bD	700x350		700x700	
ANCHOR BOLT	m-Dφ	4-25φ		8-35φ → 8-40φ	
	aA (cm²)	19.63		100.53	
cru=0.85-2.5 sPc		0.832		0.829	
REINFORCEMENT	b x D	1000 x 650		1000 x 1000	
	md, rd	550, 600		900, 950	
	mam, mat, mA (cm²)	15.89, 19.86, 55.6		39.73, 27.81, 95.35	
N<0	$_aN_{tu} = {}_aA \cdot {}_a\sigma_Y$			100.53x1.8 = 181.0	
	$_mN_u = N + {}_aN_{tu}$			-385.2+181.0 = -204.2	
	$_mM_u > M$			0.9x{27.81x3.0+½(-204.2+39.73x3.0)}	
	$= {}_md \{{}_ma_t \, {}_m\sigma_Y + \frac{1}{2}({}_mN_u + {}_ma_m \, {}_m\sigma_Y)\}$			= 36.83 > 29.2 ok	
N≥0	$_bN_{cu} = {}_bb \cdot {}_bD \cdot 0.85 \cdot F_c$	70x35x0.85x0.21		70x70x0.85x0.21	
	> N	= 437.3 > 170.5 ok		= 874.7 > 544.2 ok	
	$_cM_{cu} = {}_md \cdot {}_ma_t \cdot {}_m\sigma_Y$	0.55x19.86x3.0 = 32.8 > 22.1 ok		0.9x27.81x3.0 = 75.1 > 35.0	
	$_mM_{cu} = (bD^2 - {}_bb \cdot {}_bD^2) F_c \, c r_u / 8$				
	$_cM_{cu} + {}_mM_{cu} > M$				
Q	$_sQ_u = 0.5N + \frac{3}{4} {}_aA \cdot 0.25 \cdot {}_a\sigma_Y$	¾x19.63x0.25x1.8 = 6.63		¾x100.53x1.25x1.8 = 33.9	
	$_rQ_u = (b - {}_bb) \times \frac{7}{8} {}_rd \cdot 2F_s$	30x⅞x60x2x0.032 = 100.8		30x⅞x95x2x0.032 = 159.6	
	$_sQ_u + {}_rQ_u > Q$	6.63+100.8 = 107.4 > 73.8		193.5 > 116.8 ok	
REMARKS					

NOTATION

$F_s = \min(0.15 F_c, \; 22.5 + 4.5 F_c/100)$

$_sP_c$ = compression area of steel / bD



FORM 04

87

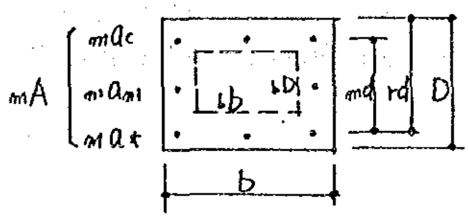
CHECK OF COLUMN BASE (3)
（柱脚の検討）

LOCATION		B-103 , 107		H-103	
COLUMN SIZE		H-350² × 12 × 19		BH-450² × 16 × 25	
DIRECTION		X	≠X	X	Y
LOAD CONDITIONS	M (tm)	22.4	31.8	19.0	
	N (t)	−129.0	416.2	652.3	
	Q (t)	74.5	106.1	63.3	
FIGURE		TYPE-~~5~~4 12-#8		TYPE-~~7~~6 18-#8	
BASE PLATE	$_bb \times {}_bD$	750 × 400		750 × 700	
ANCHOR BOLT	m − Dφ	4-25φ		8-25φ	
	$_aA$ (cm²)	19.63		39.27	
$_cr_u = 0.85 - 2.5\ _sP_c$		0.827		0.823	
REINFORCEMENT	b × D	1050 × 700		1050 × 1000	
	$_md$, $_rd$	600 , 650		900 , 950	
	$_ma_m$, $_ma_t$, $_mA$ (cm²)	31.78 , 15.89 , 63.57		31.78 , 19.87 , 71.51	
N<0	$_aN_{tu} = {}_aA \cdot {}_a\sigma_Y$	19.63 × 1.8 = 35.3			
	$_mN_u = N + {}_aN_{tu}$	−129.0 + 35.3 = −93.7			
	$_mM_u > M$	0.6 × {15.89 × 3.0 + ½ × (−93.7 + 31.78 × 3.0)}			
	$= {}_md \cdot \{{}_ma_t \cdot {}_m\sigma_Y + \frac{1}{2}({}_mN_u + {}_ma_m \cdot {}_m\sigma_Y)\}$	= 29.09 > 22.4 ok			
N≥0	$_bN_{cu} = {}_bb \cdot {}_bD \cdot 0.85 \cdot F_c$	75 × 40 × 0.85 × 0.21		75 × 70 × 0.85 × 0.21	
	> N	= 535.5 > 416.2 ok		= 937.1 > 652.3 ok	
	$_cM_{cu} = {}_md \cdot {}_ma_t \cdot {}_m\sigma_Y$	0.6 × 15.89 × 3.0 = 28.6		0.9 × 19.87 × 3.0 = 53.6 > 19.0	
	$_mM_{cu} = (bD^2 - {}_bb \cdot {}_bD^2) F_c \, {}_cr_u / 8$	(1.05 × 70² − 0.75 × 40²) × 0.21 × 0.82⁷/8 = 85.6			
	$_cM_{cu} + {}_mM_{cu} > M$	114.2 > 31.8 ok			
Q	$_sQ_u = 0.5N + \frac{3}{4} {}_aA \cdot 0.25 \cdot {}_a\sigma_Y$	3/4 × 19.63 × 0.25 × 1.8 = 6.62		0.5 × 652.3 = 326.2 > 63.3 ok	
	$_rQ_u = (b - {}_bb) \times \frac{7}{8} {}_rd \cdot 2F_s$	30 × 7/8 × 65 × 2 × 0.032 = 109.2			
	$_sQ_u + {}_rQ_u > Q$	115.8 > 106.1 ok			
REMARKS					

NOTATION

$F_s = \min(0.15 F_c\ ,\ 22.5 + 4.5 F_c / 100)$

$_sP_c$ = compression area of steel / bD



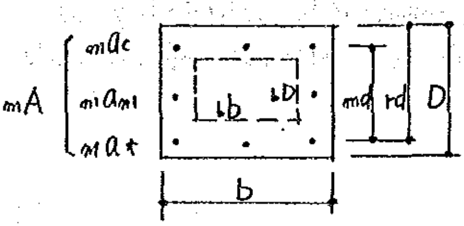
CHECK OF COLUMN BASE (4)
（柱脚の検討）

LOCATION		H-106		H-108	
COLUMN SIZE		H-516×500×22×40		H-516×500×22×40	
DIRECTION		X	Y	X	Y
LOAD CONDITIONS	M (tm)	19.0	33.7	49.3	
	N (t)	709.8	682.2	1,067.2	
	Q (t)	63.3	112.3	164.2	
FIGURE		TYPE-87 20-#8		TYPE-98 24-#8	
BASE PLATE	bb × bD	700×916		916×1100	
ANCHOR BOLT	m – Dφ	8-25φ		8-25φ	
	aA (cm2)	39.27		39.27	
$c r_u = 0.85 - 2.5\ sP_c$		0.809		0.821	
REINFORCEMENT	b × D	1000×1216		1216×1400	
	md, rd	1116, 1166		1300, 1350	
	mam, mat, mA (cm2)	39.73, 19.86, 79.46		39.73, 27.81, 95.35	
N<0	$aN_{tu} = aA \cdot a\sigma_Y$				
	$mN_u = N + aN_{tu}$				
	$mM_u > M$				
	$= md \{ ma_t \cdot m\sigma_Y + \frac{1}{2}(mN_u + ma_m \cdot m\sigma_Y) \}$				
N≥0	$bN_{cu} = bb \cdot bD \cdot 0.85 \cdot F_c$	70×91.6×0.85×0.21		91.6×110×0.85×0.21	
	$> N$	= 1,144.5 > 682.2		= 1,798 > 1,067.2	
	$cM_{cu} = md \cdot ma_t \cdot m\sigma_Y$	1.116×19.86×3.0 = 66.5 > 33.7 ok		1.3×27.81×3.0 = 108.5 > 49.3 ok	
	$mM_{cu} = (bD^2 - bb \cdot bD^2) F_c \cdot c r_u / 8$				
	$cM_{cu} + mM_{cu} > M$				
Q	$sQ_u = 0.5N + \frac{3}{4} aA \cdot 0.25 \cdot a\sigma_Y$	0.5×682.2 = 341.1 > 112.3 ok		0.5×1067.2 = 533.6 > 164.2 ok	
	$rQ_u = (b - bb) \times \frac{7}{8} rd \cdot 2F_s$				
	$sQ_u + rQ_u > Q$				
REMARKS					

NOTATION

$F_s = \min(0.15 F_c,\ 22.5 + 4.5 F_c/100)$

sP_c = compression area of steel / bD



FORM 04

89

ＡＲ－２ 発 電 所 本 館（下部構造）

構 造 計 算 書

目　　　次

1. General (一般事項)

1-1. Design Loads and code (設計荷重及び規準)

Dead and live load, equipment load ,crane load, column loads are refered to calculation sheet of superstructure structural analysis.

Coad ; AIJ

Standards for Calculation for Reinforced Concrete

Standards for Structural Design of Building Foundations

1-2. Allowable stresses of materials (材料の許容応力度)

Allowable stresses of materials are refered to the next page. Grade of materials to be used for the substructure structural analysis are shown below.

Concrete	Fc= 210Kg/cm^2 (3,000 psi)
Re-bar	SD-30 or equivalent (ASTM A 615 Grade 40)
Steel pipe pile	ϕ-609.6×9.0 STK-41

1-3. Column axial force & Loading diagram (柱/その他荷重表)

See the attached sheets page- .

1-4. Assumptions (仮定条件)

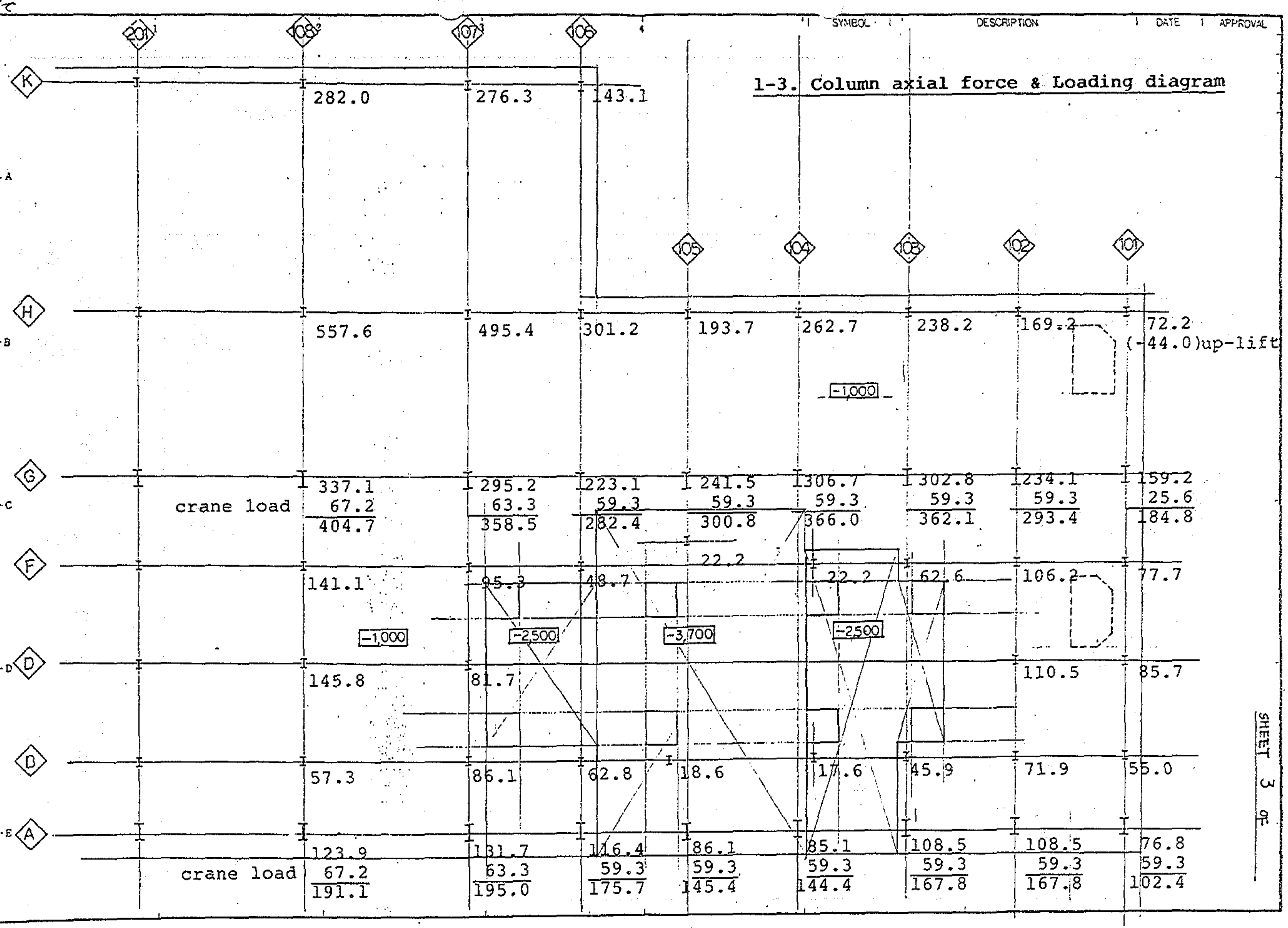
a) Column axial force of boiler structure and T/G pedestal are assumed as a 200MW of power plant.

b) Analysis of mat foundation

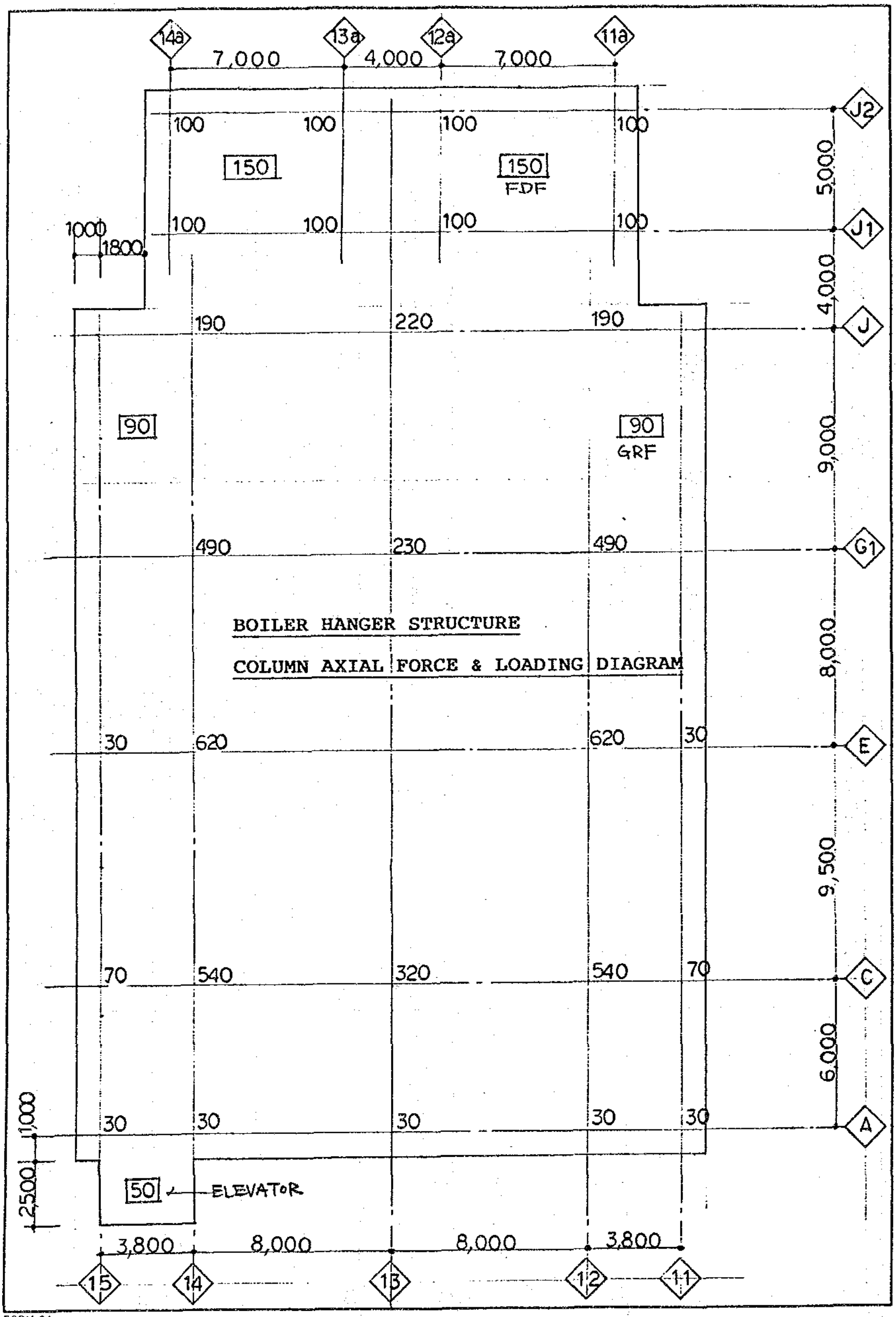
Maximum un-uniformed sinking is 1/15,000 of longitudinal length of mat foundation(l=111.6m). Therefore, the stress of the mat is calculated in consideration of 7.44mm sinking.

SYMBOL | DESCRIPTION | DATE | APPROVAL

1-3. Column axial force & Loading diagram



SHEET 3 of


BOILER HANGER STRUCTURE
COLUMN AXIAL FORCE & LOADING DIAGRAM
14a
13a
12a
11a
7,000
4,000
7,000
J2
J1
J
G1
E
C
A
5,000
4,000
9,000
8,000
9,500
6,000
100
100
100
100
150
150
FDF
100
100
100
100
1000
1800
190
220
190
90
90
GRF
490
230
490
30
620
620
30
70
540
320
540
70
30
30
30
30
30
1,000
2,500
50
ELEVATOR
3,800
8,000
8,000
3,800
15
14
13
12
11

2. Culculation of allowable bearing capacity of pile (杭の許容耐力)

2-1. Allowable axial force of pile material (STK 41)

(杭材料の許容耐力)

Allowable compression strength of material : $_{L}fc$ = 1.372 T/cm^2

Gross sectional area of pile : $_{G}Ap$ = 131.6 cm^2

Decreasing ratio due to the welded joint : 5 % decrease

Ra = 1.372 T/cm^2 × 131.6 cm^2 × 0.95 = 172 ton/pile

2-2. Allowable bearing capacity of pile due to soil condition

(地盤による杭の許容耐力)

ϕ 609.6 ×9.0 Effective thickness is 9.0 - 2.0 = 7.0 mm

GL -26.0 m L=23.5 m

The allowable bearing capacity of steel pipe pile by soil is culculated according to the following formula.

$$Ra = \frac{1}{3} \times \{\eta \times 30 \cdot N \cdot Ap + \Sigma \frac{N}{5} \times \Psi \times Ls\}$$

where, η : Coefficient of open bottom end of steel pipe pile 0.66

N : N-value of bearing stratum / N-value of sandy stratum

N = 50 N = 22.4

Ap : Area of pile 0.292 m ^{2}

Ψ : Circumference of pile 1.914 m

Ls : Pile length in the sandy stratum 16 m

Ra = 142.1 ton/pile

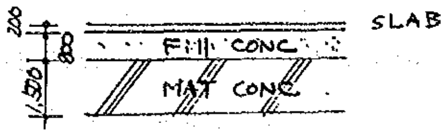
Therefore, the allowable bearing capacity of steel pipe pile is determined <u>140 ton/pile</u> .

3 CALCULATION FOR NUMBERS OF PILE (杭本数の算定)

3.1 LOADS (荷重)

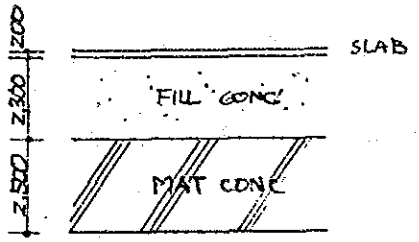
(1) T/G Room & T/G PEDESTAL

(a) DEAD LOAD



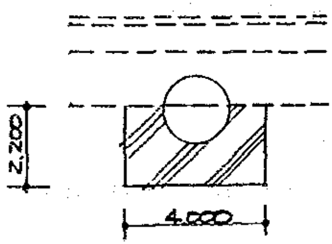
T/G ROOM

	t(m)		T/m³		T/m²
SLAB	0.2	×	2.4	=	0.48
FILL CONC	0.8	×	1.8	=	1.44
MAT	1.5	×	2.4	=	3.60
					5.52 T/m²



FOR T/G PEDESTAL MAT.

SLAB	0.2	×	2.4	=	0.48
FILL CONC	2.3	×	1.8	=	4.14
MAT	2.5	×	2.4	=	6.0
					10.62



FOR C.W. PIPE

CONC. 2.2 × 4.0 × 2.4 = 21.12 T/m

WALL.

PRECAST CONCRETE PANEL
t=120mm h=5.5m

0.12 × 5.5 × 2.4 = 1.58 T/m
0.15 × 1.0 × 2.4 = 0.36
1.94 T/m

CONCRETE WALL
COLUMN LINE A
t=300mm h=3.7m

0.3 × 3.7 × 2.4 = 2.66 T/m
1.58
4.24 T/m

(b) LIVE LOAD.

EQUIPMENTS LOAD FOR ALL AREA	0.35 T/m²
BOILER FEED PUMP (BFP)	30 TON × 3 UNITS
MAIN OIL TANK	60 TON
COOLING WATER HEAT EXCHANGER	58 TON × 2 UNITS
CONDENSATE PUMP	20 TON × 2 〃

(C) T/G PEDESTAL

TURBINE	HP+LP = 165 + 215 =	380 TON
GENERATOR		320 TON
PEDESTAL	$800 m^3 \times 2.4$	1,920 TON
		2,620 TON

AREA OF FOUNDATION

$31.5 \times 13.0 = 409.5 m^2 \Rightarrow 6.40$ TON/m^2.

BOTTOM OF CONDENSOR (870 TON)

AREA OF CONDENSOR.

$8.0 \times 13.0 = 104.0 m^2 \Rightarrow 8.37$ TON/m^2

(D) UNIT LOAD FOR FOUNDATION

FOR T/G ROOM.

	5.52
	0.35
	5.87 TON/m^2

FOR T/G PEDESTAL

CONDENSOR	8.37	—
T/G.	6.40	6.40
MAT	6.00	10.62
	20.77 T/m^2	17.02 T/m^2

FOR C.W. PIT.

	3.60
PIPING	1.00
	4.60 T/m^2

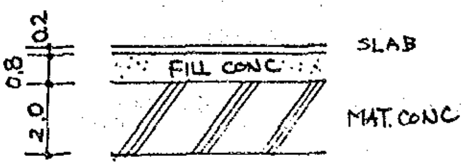
(E) OVER-TURNING MOMENT OF T/G PEDESTAL (ASSUMED) ℄ c/mass

TURBINE	380 × 0.1	=	38	14.7 m
GENERATOR	320 × 0.1	=	32	14.7 m
PEDESTAL	1,920 × 0.1	=	192	12.7 m

$$M = (38+32) \times 14.7 + 192 \times 12.7 + (38+32+192) \times 2.5$$
$$+ 31.5 \times 13.0 \times 2.5 \times 2.4 \times 0.05 \times 2.5 \times 1/2$$
$$= 508.4 + 2,438.4 + 655.0 + 153.6 = 3.755.4 \text{ Tm}$$

(2) Boiler MAT

(a) DEAD LOAD



	t(m)	T/m³		T/m²
SLAB	0.2 ×	2.4	=	0.48
FILL CONC'	0.8 ×	1.8	=	1.44
MAT	1.5 ×	2.4	=	3.60
				5.52 T/m²

(b) LIVE LOAD

MISC. EQUIPMENT FOR ALL AREA ------------ 0.35 T/m²

FDF 50 TON × 2 UNITS = 100 TON

GRF 20 × 2 = 40 TON

ELEVATOR 50 TON

(c) UNIT LOAD FOR FOUNDATION

DEAD	5.52
LIVE	0.35
	5.87 → 5.87 T/m²

(d) ASSUMING OF THE AXIAL FORCE OF MAIN COLUMNS OF BOILER STRUCTURE AT SEISMIC TERM.

WEIGHT OF BOILER	3,200 TON
〃 OF STRUCTURE	770 TON
	3,970 TON
SEISMIC COEFFICIENT	K = 0.13
NUMBER OF MAIN BRACE	6
HEIGHT OF CENTER OF MASS	h = 27 m
STANCE OF BRACE	8 m

$$N = 3.970 \times 0.13 \times 27 \times \frac{1}{6} \times \frac{1}{8} = \pm 290 \text{ TON}$$

(e) WEIGHT OF EQUIPMENT FOUNDATION (ABOVE FL±0)

FDF. 8 m × 2.5 m × 2 m × 2.4 = 96 TON/UNIT

GRF 6 m × 2.5 × 2 × 2.4 = 72 TON/UNIT

SHEET 9 OF

Calculation of number of pile (杭本数の算定) M.P.H -1

Column No.	Col.load ton	Area m2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
A-101	102.4	12.1	71.0		7.15m 13.9	—	187.3	2.0	93.7
102	167.8	18.7	109.8		13.2	—	290.8	3.0	96.9
103	167.8	11.9 + 18.7	264.7 (179.6 / 85.1)	(4.3×1.5×5.5×2.4	13.2	—	445.7	4.0	111.4
104	144.4	11.9 + 18.7	200.2 (140.8 / 59.4)	(3.0×1.5×5.5×2.4	28.8	—	373.4	3.5	106.7
105	145.4	11.9 + 18.7	140.8		28.8	—	315.0	4.0	78.8
106	175.7	11.9 + 18.7	268.7 (179.6 / 89.1)	(2.5×2.7×5.5×2.4	13.2	—	457.6	4.5	101.7
107	195.0	23.1	135.6		16.3	—	346.9	4.25	81.6
108	191.1	27.5	161.4		19.4	—	371.9	4.5	82.6
	1289.6	156.2 + 47.6 = 203.8				(subtotal)	(2788.6)	(29.75)	(93.7)
B-101	55.0	23.1	135.6		10.2	60×1/6 10.0	210.8	2.5	84.3
102	71.9	34.3	201.3		—	10.0	283.2	2.5	113.3
103	T/G ← 45.9	A-103 ← 11.9					—	T/G PEDESTAL	
104	T/G ← 17.6	A-104 ← 11.9					—		
105	T/G ← 18.6	A-105 ← 11.9					—		
106	T/G ← 62.8	A-106 ← 11.9					—		
107	T/G ← 86.1	30.45	178.7		—	58×1/3 19.3	198.0	1.75	113.1
108	57.3	52.5	308.7		—	19.3	385.3	4.0	96.3
	415.2	140.35					(1077.3)	(10.75)	(100.2)

FORM 04

Calculation of number of pile (杭本数の算定)　MPH - 2

Column No.	Col.load ton	Area m2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
D - 101	85.7	+13.4 26.4	+16.3 155.0	—	11.6	10	+16.3 262.3	2.5	111.4
- 102	110.5	38.4	225.4	—	—	10	345.9	3.5	98.8
107	T/G ← 81.7	27.0	158.5	—	—	19.3	177.8	2.0	88.9
108	145.8	60.0	352.2	—	—	19.3	516.5	5.0	103.3
	423.7					(subtotal)	(1.302.5)	(13.0)	(100.2)
F - 101	77.7	+13.6 25.3	+16.3 148.5	—	11.2	10	+16.3 247.4	2.5	105.5
102	106.2	37.7	221.3	—	—	10	337.5	3.5	96.4
103	T/G ← 62.6	17.0	161.5 (99.8 / 61.7)	1.0×2.5×3.9×2.4 / 2.2×2.5×2.9×2.4	—	20	181.5	1.5	121.0
104	T/G ← 22.2	17.0	135.8 (99.8 / 36.0)	1.0×2.9×2.25×2.4 / 1.5×2.9×1.95×2.4	—	20	155.8	1.5	103.9
105	T/G ← 22.2	17.0	99.8	—	—	—	99.8	1.5	66.5
106	T/G ← 48.7	17.0	158.1 (99.8 / 58.3)	2.7×2.25×4.0×2.4	—	—	158.1	1.25	126.5
107	T/G ← 95.3	34.65	203.4	—	—	19.3	222.7	2.25	99.0
108	141.1	57.5	337.5	—	—	19.3	497.9	5.0	99.6
	576.0						(1.900.7)	(19.0)	(100.0)
G - 101	184.8	34.1	200.2	—	15.0	—	400.0	4.5	88.9
102	293.4	52.7	309.4	—	—	—	602.8	6.5	92.7
103	362.1	52.7	334.9 (309.4 / 25.5)	1.25×3.4×2.5×2.4	—	—	697.0	7.5	92.9
104	366.0	52.7	472.3 (309.4 / 162.9)	5.2×3.8×2.5×2.4 / 21.12×1/2×4.2	—	—	838.3	8.0	104.8

FORM 04

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FORM 04

Calculation of number of pile (杭本数の算定) MPH-3

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
G-105	300.8	52.7	508.8 (309.4 / 199.4)	6.8×3.8×2.5×2.4 / 21.1×½×4.2	—	—	809.6	8.0	101.2
106	282.4	52.7	440.6 (309.4 / 131.2)	5.2×3.8×2.5×2.4 / 2.8×0.75×2.5×2.4	—	—	723.0	8.25	87.6
107	358.5	65.1	382.1	—	—	—	740.6	8.25	89.8
108	404.3	77.5	454.9	—	—	—	859.2	8.5	101.1
	2,552.3					(Subtotal)	(5,670.5)	(59.5)	(95.3)
H-101	72.2	26.4	+ 31.7 / 155.0	—	20.2	—	+ 31.7 / 247.4	3.0	93.0
102	169.2	40.8	239.5	—	13.2	—	421.9	5.0	84.4
103	238.2	40.8	239.5	—	13.2	30	520.9	5.0	104.2
104	262.7	40.8	302.9 (239.5 / 63.4)	21.1×½×6	13.2	15	593.8	5.0	118.8
105	193.7	40.8	302.9		13.2	15	524.8	5.0	106.0
106	301.2	69.2	399.5	—	8.4 16.3	15	727.0	8.25	88.1
107	495.4	100.8	591.7	—	—	15	1,102.1	10.0	110.0
108	557.6	120.0	704.4	—	—	—	1,262.0	11.0	114.7
	2,290.2						(5399.9)	(52.25)	(103.3)
K-106	143.1	35.2	206.6	—	12.4 24.1	—	373.8	4.75	78.7
107	276.3	67.2	394.5	—	9.4 16.3	—	687.1	6.0	114.5
108	282.0	80.0	469.6	—	19.4	—	771.0	7.0	110.1
						(Subtotal)	(1831.9)	(17.75)	(103.2)

SHEET 12 OF

Calculation of number of pile (杭本数の算定) MPH - 4. T/G PEDESTAL

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
T/G PEDESTAL	563.7	409.5							
		104.0 × 20.77 = 2160.1					2160.1		
		305.5 × 17.02 = 5199.6		1.5×1.5×13 = 1.5×1.5×6.8×2 =	100.0 m³ × 2.4 = 241.0		5440.6		
				1.5×1.5×13 = 1.5×1.5×2.5×2 =			563.7		
							8164.4	84	97.2
							(19.94 TON/m²)		
T/G ROOM									
TOTAL	7,684.7	1771.7					19.971.4	202	98.9
							(11.27 TON/m²)		

FORM 04

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FORM 04

Calculation of number of pile (杭本数の算定) BOILER AREA -1

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
A - 11	30.0	11.6	68.1				98.1	1.5	65.4
12	30.0	23.6	138.5				168.5	2.25	74.9
13	30.0	32.0	187.8				217.8	3.0	72.6
14	30.0	23.6	138.5				168.5	2.25	74.9
15	30.0	11.6	68.1				98.1	1.5	65.4
C - 11	70.0	22.48	132.0				202.0	2.0	101.0
12	540.0	45.73	268.4				808.4	7.0	115.5
13	320.0	62.0	363.9				683.9	6.0	113.9
14	540.0	45.73	268.4				808.4	7.0	115.5
15	70.0	22.48	132.0				202.0	2.0	113.9
E - 11	30.0	25.38	149.0				179.0	2.0	89.5
12	620.0	51.63	303.1				923.1	8.0	115.4
13	—	70.0	410.9				410.9	4.0	102.5
14	620.0	51.63	303.1				923.1	8.0	115.4
15	30.0	25.38	149.0				179.0	2.0	89.5

Calculation of number of pile (杭本数の算定) BOILER AREA - 2

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
G1 - 11	—	24.65	144.7			GRF 22.5	167.2	2.0	83.6
12	490	50.15	294.4			22.5	806.9	7.0	115.2
13	230	68.0	399.2				629.2	6.0	104.9
14	490	50.15	294.4			22.5	806.9	7.0	115.2
15	—	24.65	144.7			22.5	167.2	2.0	83.6
J - 11	—	15.95	93.6			22.5	116.1	1.5	77.4
12	190	38.35	225.1			22.5	437.6	4.25	103.0
13	220	52.0	305.2				525.2	5.0	105.0
14	190	38.35	225.1			22.5	437.6	4.25	103.0
15	—	15.95	93.6			22.5	116.1	1.5	77.4
J1 - 11a	100	20.25	118.9			FDF 37.5	256.4	2.25	114.0
12a	100	24.75	145.3			37.5	282.8	2.25	125.7
13a	100	20.25	145.3			37.5	282.8	2.25	125.7
14a	100	24.75	118.9			37.5	256.4	2.25	114.0

FORM 04

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Calculation of number of pile (杭本数の算定) BOILER AREA -3

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
J2-11a	100	15.75	92.5			37.5	230.0	2.25	102.2
12a	100	19.25	113.0			37.5	250.5	2.25	113.3
13a	100	19.25	113.0			37.5	250.5	2.25	113.3
14a	100	15.75	92.5			37.5	230.0	2.25	102.2
ELEVATOR	50	9.5	55.8			—	105.8	1.0	105.8
TOTAL	5650	1072.54					12,426.0	118.	105.3
							(11.59 ton/m²)		

FORM 04

Calculation of number of pile (杭本数の算定)

Column No.	Col.load ton	Area m^2	Mat ton	Fill conc. ton	Wall ton	Equip. ton	Total ton	Numbers of pile	Ton/pile
Transformer Yard Foundation									
Main Trans	—	$10.3 \times 10.3 = 106.1$	$3.1 \times 2.4 = 7.44$ 789.4	—	$0.25 \times 6 \times 8.5 \times 2.4 \times \frac{1}{2}$ 15.3	240.0	1044.7	12	87.1
Aux. Trans	—	$6.1 \times 6.0 = 36.6$	272.3	—	$0.25 \times 6 \times 7.0 \times 2.4 \times \frac{1}{2}$ 15.3 + 12.6	42.0	342.2	4	85.6
St. Trans	—	36.6	272.3	—	12.6	52.0	336.9	4	84.2
Unit -1	M.Tr. + Aux Tr + St Tr.	179.3	1334	—	55.8	334.0	1.723.8	20	86.2
Unit -2	M.Tr + Aux Tr.	142.7	1061.7	—	55.8	282.0	1.399.5	16	87.5
TOTAL								36	

FORM 04

3-3. TABULATION OF LOAD & NUMBERS OF PILE （荷重／杭本数総括表）

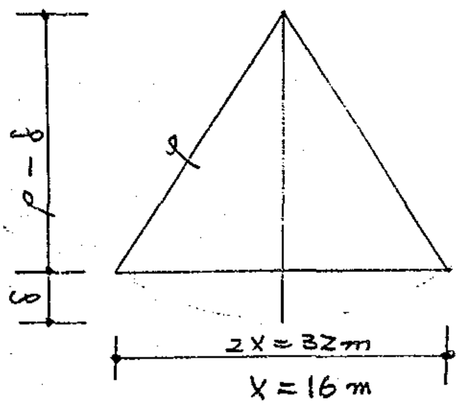
Location	Loads			Numbers of Pile	tons/ pile	tons/ m^2
	Super-structure	Sub-structure	Total Weight			
T/G ROOM	7,684.7	12,286.7	19,971.4	202	98.9	11.27
T/G PEDESTAL	4,053.7	4,110.7	8,164.4	84	97.2	19.94
Trans Unit-1	389.8	1,334.0	1,723.8	20	86.2	9.61
Trans Unit-2	337.8	1,061.7	1,399.5	16	87.5	9.81
Boier Area	5,650.0	6,776.0	12,426.0	118	105.3	11.59
Total			84,246.9	844	99.8	

4. CALCULATION OF BENDING MOMENT OF MAT FOUNDATION DUE TO THE STTLEMENT.

Longitudinal length of mat : $l = 111.6m$

Max. sinking value of mat : $l \times \frac{1}{15,000} = 7.^{44} mm = \delta$

Bending moment : $M = \frac{EI}{\rho}$



$\rho \fallingdotseq \frac{\delta^2 + X^2}{2\delta}$

$= \frac{0.00744^2 \times 16^2}{2 \times 0.00744}$

$= 17.204$

$E = 2.1 \times 10^5 \times \left(\frac{\gamma}{2.3}\right)^{1.5} \times \sqrt{\frac{Fc}{200}}$

$\gamma : 2.3 \quad Fc = 210$

$= 2.152 \times 10^5 \ kg/cm^2$

T/G mat Foundation

$A = 1.0 \times 2.^5 = 2.5 m^2$

$I = \frac{1}{12} \times 1.0 \times 2.5^3 = 1.302 m^4$

$M = \frac{2.152 \times 10^6 \times 1.302}{17,204} = 162.^8 \ Tm/m$

$at = \frac{162.8 \times 10^5}{1,867 \times 240 \times 7/8} = 41.^5 cm^2$

#7 @150 Double, (51.6 cm²)

T/G Room. & BOILER MAT FOUNDATION

$A = 1.0 \times 1.5 = 1.5 m^2$

$I = \frac{1}{12} \times 1.0 \times 1.5^3 = 0.281 m^4$

$M = \frac{2.152 \times 10^6 \times 0.281}{17,204} = 35.^1 \ Tm/m$

$at = \frac{(35.^1 + 15.^6) \times 10^5}{1,867 \times 140 \times 7/8} = 22.^2 cm^2$

→ see next page

#7 @ 150 single (25.⁸ cm²)

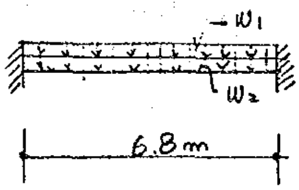
FORM 04

Max moment of mat (Slab)

$w = 5.87\ t/m^2 \quad l_x = 6.0 \quad l_y = 10.0 \quad \lambda = \frac{l_y}{l_x} = 1.67$

$M_{max.} = 0.074 \times 5.87 \times 6.0^2 = \underline{15.6\ Tm/m}$

Moment at the part of Cooling Water Pipe



$w_1 = 5.8^7 + 4.4^1 = 10.^{28}\ T/m$ (BFP)

$w_2 = 5.^{28}\ t/m$ (C.W Pipe covering Concrete)

$w = 10.^{28} + 5.^{28} = 15.6\ T/m$

$C = \frac{1}{24} \times 15.6 \times 6.8^2 = 30.^1\ tm/m$ (upper)

$M_0 = \frac{1}{8} \times 15.^6 \times 6.8^2 = 90.^2\ tm/m$

$M_c = 90.^2 - 30.^1 = 60.^1\ tm/m$ (bottom)

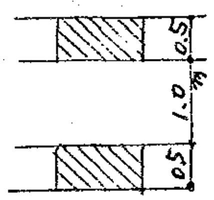
$_uM_{max} = 35.^1 + 30.^1 = 65.^1\ tm$

$a_t = \frac{65.^1 \times 10^5}{1.867 \times 140 \times 7/8} = 28.^5\ cm^2$ #17 @150 + @300 (2段目) ($38.^7 cm^2$)

$_BM_{max} = 35.^1 + 60.^1 = 95.^2\ tm$

$a_t = \frac{95.^2 \times 10^5}{1.867 \times 350 \times 7/8} = 16.^{65}\ cm^2$ #7 @ 150 ($25.8 cm^2$)

Sump Pit Area



$A = 1.0 \times 1.0 = 1.0\ m^2$

$I = 2 \times 0.5 \times 1.0^2 = 1.0\ m^4$

$M = \frac{2.152 \times 10^6 \times 1.0}{17{,}204} = 125\ Tm/m$

$a_t = \frac{125 \times 10^5}{1.867 \times 190 \times 7/8} = 40.^2\ cm^2$

#7 @ 150 Double ($51.^6 cm^2$)

FORM 04

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Upper Slab

$l_x = 4.2 \quad l_y = 2.6 \quad \lambda = 1.62$

$w = 0.5 \times 2.4 + 0.8 \times 1.8 + 0.2 \times 2.4 + 0.35 = 3.47\ t/m^2$

$M_{max} = 0.073 \times 3.47 \times 4.2^2 = 4.5\ Tm/m$

$$A_t = \frac{450}{1.867 \times 45 \times 7/8} = 6.12\ cm^2$$

$40.2 + 6.12 = 46.32 << 51.6\ cm^2$

$\therefore$ #7 @ 150 Double .... ok

3/0

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構 造 計 算 書

目　　次

3/2

I．排ガス条件と内筒設計

1. DESIGN CONCEPT FOR DECISION OF FLUE INSIDE DIAMETER [内筒直径決定の考え方]

The effective inside diameter of flue shall be decided so as to conform to the following requirements:

a. Exhaust gas velocity at the top of stack shall be more than 30 m per second under the operation condition of ECR from the view point of environmental pollution protection.

b. The required forced draft at the breeching opening of flue shall be less than 50 mmAq under the operation condition of MCR from the view point of the boiler efficiency.

2. DESIGN CONDITION [設計条件]

2.1 Climate condition [気象条件]

Ambient temperature	25 ℃
Specific gravity of air at 0℃ and 1013 mili-bar	1,293

2.2 Exhaust gas condition [排出ガス条件]

Operation	ECR	MCR
Temperature ℃	145	145
Gas volume Nm^3 /sec	157	165
Qg=Nm^3 /sec(at gas temp.)	240.4	252.6
Specific gravity of gas (Kg/Nm^3)	1.293	1.293
· at gas temp.($\gamma g=kg/m^3$)	0.845	0.845

3. DECISION OF FLUE DIAMETER [内筒直径の決定]

3.1 Decision of a nozzle diameter at the flue top [内筒頂部直径の決定]

Required cross sectional area of a nozzle to keep the exhaust gas velocity of 30 m/sec under condition of ECR is;

$$\text{Req } A = \frac{Qg}{30} = \frac{240.4}{30} = 8.0 \ m^2$$

Therefore, diameter is

$$d = \sqrt{\frac{8.0 \times 4}{\pi}} = 3.19 \ m\phi$$

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Decided cross sectional area of top nozzle having diameter of 3.15 m is 7.79 m^2 .

3.2 Decision of effective diameter of flue [内筒有効直径の決定]

1) Natural draft force (theoretically calculated) under condition of MCR. [自然通気力の計算]

Specific gravity of air (γa) at 25 ℃ of ambient temperature is

$$\gamma a = 1.293 \times \frac{273}{273 + 25} = 1.185$$

Height of breeching opening center is 10.0 m above ground and specific gravity of gas at temperature of 145℃ is 0.845.

Therefore, natural draft force (Z) can be calculated as follows:

$Z = (140.0 - 10.0) \times (1.185 - 0.845) \times 0.95 = 42.0$ mmAq

Where, 0.95 is reduction factor due to gas temperature drop between opening and top nozzle.

2) Calculation of pressure loss (Δh) [圧力損失の計算]

a) Exhaust loss at top nozzle(Δh_1) [頂部の排出損失]

$$\Delta h_1 = \lambda_1 \frac{\gamma g}{2g} V_{g1}^2 \qquad V_{g1} = \frac{252.6}{7.79} = 32.43 \text{ m/sec}$$

$$= 1.2 \times \frac{0.845}{2 \times 9.8} \times 32.43^2$$

$$= 54.4 \text{ mmAq}$$

b) Friction loss in flue(Δh_2) (内筒の摩擦損失)

$$\Delta h_2 = \lambda_2 \frac{\gamma g}{2g} V_{g2}^2 \times \frac{H}{D}$$

Here, assuming that the flue diameter is 3.5 m, cross sectional area of flue is 9.621m^2 .

Therefore, gas velocity in flue becomes 26.26 m/sec.

$\Delta h_2 = 0.02 \times 0.0431 \times 26.26^2 \times 130/3.5 = 22.1$ mmAq

c) Connection loss at breeching opening [内筒への入口損失]

Dimension of breeching opening is 2m×7m and area is 14.0m^2 .

Gas velocity(V_{g3}) at breeching opening is 18.04 m/sec.

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Therefore, connection loss can be calculated as follows;

$$\Delta h_3 = \lambda_3 \frac{\gamma g}{2g} V_{g3}^2$$

$$= 1.05 \times 0.0431 \times 18.04^2 = 14.7 \text{ mmAq}$$

d) Total pressure loss [合計損失]

$$\Delta h = \Delta h_1 + \Delta h_2 + \Delta h_3$$

$$= 54.4 + 22.1 + 14.7 = 91.2 \text{ mmAq}$$

e) Required forced draft[必要強制通気力] can be obtained by subtracting natural draft force (Z) from total pressure loss

$\Delta h - Z = 91.2 - 42.0 = 49.2$ mmAq $<$ 50 mmAq

Consequently, the diameter of stack is decided as follows:

Top nozzle (effective) [有効頂部直径] ϕ 3.15 m

Flue(effective) [有効内筒直径] ϕ 3.5 m

The dimension of reinforced concrete windshield is decided based upon the inner flue diameter. Refer to the Secton II.

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II. 構造計算

1. GENERAL
[一般事項]

1-1 DESIGN BASIS [設計基本事項]

The reinforced concrete chimney (Height : 137 m) for the West Wharf Thermal Power Plant Project Units No.1 and No.2 is designed to resist stresses resulting from the weight of the chimney, and the effect of temperature, wind and earthquake.

The dynamic analysis is used for the seismic load as well as the static analysis. The maximum stresses are applied for the decision of the section of the windshield and the foundation.

The stresses are calculated in accordance with the Architectural Institute of Japan. The section is decided so that the stresses do not exeed the allowable stresses. Also, the economical section is considered.

Table of Reinforcing Bars (ASTM Standard)

SIZE	NOMINAL DIAMETER (mm)	NOMINAL AREA (mm2)
# 3	9.52	71
# 4	12.70	129
# 5	15.88	200
# 6	19.05	284
# 7	22.22	387
# 8	25.40	510
# 9	28.65	645
#10	32.26	819
#11	35.81	1006
#14	43.00	1452
#18	57.33	2581

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1-2 ALLOWABLE STRESS
[許容応力度]

(1) ALLOWABLE UNIT STRESS OF CONCRETE (kg/cm2)

		PERMANENT CONDITIONS				TEMPORARY CONDITIONS		
		COMPRESSION	SHEAR	BOND		COMPRESSION	SHEAR	BOND
				A	B			
NORMAL CONCRETE Fc=270	BAR 1	90	7.7	9.0	13.5	PERMANENT CONDITIONS x 2.0	PERMANENT CONDITIONS x 1.5	
	BAR 2			16.2	24.3			

NOTE : BAR 1 --- PLAIN BAR
BAR 2 --- DEFORMED BAR
A --- TOP BAR OF FLECTIONAL MEMBER
B --- OTHER BARS

(2) ALLOWABLE UNIT STRESS OF REINFORCED BARS (kg/cm2)

	PERMANENT CONDITIONS		TEMPORARY CONDITIONS	
	TENSION COMPRESSION	FOR SHEAR	TENSION COMPRESSION	FOR SHEAR
DEFORMED BAR ASTM A615 GRADE 40	1,870	1,870	2,800	2,800

(3) ALLOWABLE UNIT STRESS OF STRUCTURAL STEEL (kg/cm2)

	PERMANENT CONDITIONS		TEMPORARY CONDITIONS	
	COMPRESSION TENSION BENDING	SHEAR	COMPRESSION TENSION BENDING	SHEAR
STRUCTURAL STEEL SS41 AND SM41A THICKNESS ≦ 40mm	1,600	920	2,400	1,380
STRUCTURAL STEEL SS41 AND SM41A THICKNESS > 40mm	1,460	840	2,200	1,270

(4) ALLOWABLE UNIT STRESS OF WELDING JOINT (kg/cm2)

		PERMANENT CONDITIONS		TEMPORARY CONDITIONS	
		BUTT WELD	FILLET WELD AND SHEAR	BUTT WELD	FILLET WELD AND SHEAR
SS41 AND SM41A THICKNESS≦ 40mm	A	1,440	830	2,160	1,245
	B	1,200	700	1,800	1,050
SS41 AND SM41A THICKNESS> 40mm	A	1,320	760	1,980	1,140
	B	1,100	635	1,650	950

NOTE : A --- FLAT OR HORIZONTAL POSITION
B --- OVERHEAD OR VERTICAL POSITION

(3) BEARING CAPACITY OF STEEL PIPE PILE (t/pile)

	PERMANENT CONDITIONS	TEMPORARY CONDITIONS
STEEL PIPE PILE φ 609.6x9 STK41	120	240

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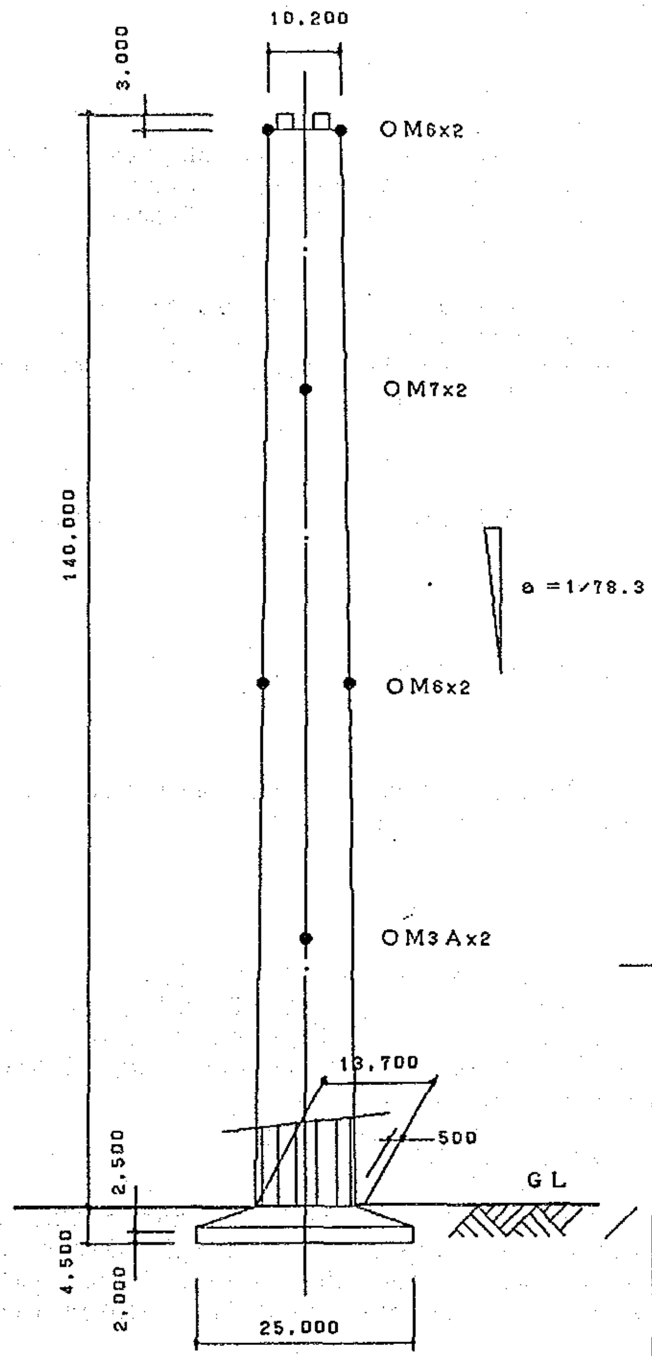
2. STRUCTURAL DATA

2-1 STRUCTURAL DATA

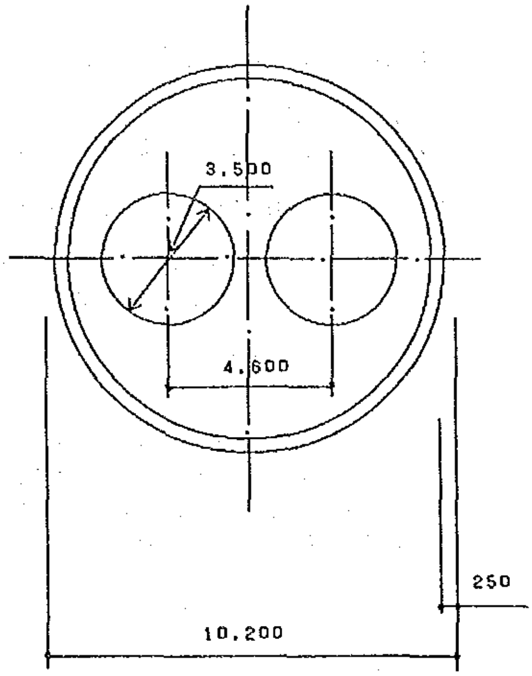
[構造概要]

DESIGN CONDITIONS [設計条件]				
FUEL		OIL		
EXHAUST GAS VOLUME (Nm3/sec)		157 (ECR)	165 (MCR)	
EXHAUST GAS TEMPERATURE (℃)		145		
TYPE		INNER FLUE TYPE		
DIMENSION [各部寸法]				
TOTAL HEIGHT (m)	Ho	140		
HEIGHT OF WINDSHIELD (m)	Hw	137		
TOP OUTER DIAMETER (m)	Dt	10.2		
BOTTOM OUTER DIAMETER (m)	Db	13.7		
TOP WALL THICKNESS (m)	Tt	0.25		
BOTTOM WALL THICKNESS (m)	Tb	0.5		
SLOPE (2xHw/(Db-Dt))	S	78.29		
EFFECTIVE DIAMETER OF INNER FLUE (m)		3.5		
INSIDE DIAMETER OF INNER FLUE (m)		3.6		
FOUNDATION [基礎形式]				
TYPE		OCTAGONAL RC FOUNDATION		
WIDTH (m)		25		
SUPPORTING SYSTEM		STEEL PIPE PILE φ 609.6x9		
LINING AND INSULATION [ライニング及び保温材]				
LINING MATERIAL (THICKNESS:50mm)		GUNITE TYPE CASTABLE LINING		
INSULATION MATERIAL (THICKNESS:50mm)		GLASS FIBER		
MATERIAL QUANTITY [材料数量]				
REINFORCED CONCRETE (m3) &	WINDSHIELD	1,900 m3		
REINFORCED STEEL BAR (t)	FOUNDATION	1,850 m3		
STEEL (t)		280 t		
NUMBER OF PILE		124 piles		
QUALITY OF STRUCTURAL MEMBER [構造材料仕様]				
REINFORCED CONCRETE		Fc = 270 kg/cm2		
REINFORCED STEEL BAR		GRADE 40 (ASTM A615)		
INNER FLUE		SM41A		
DEAD WEIGHT (t) [重量]				
WINDSHIELD	ρ = 2.4 t/m3	4,560 t		
INNER FLUE	ρ = 7.86 t/m3	2 t/m	t/m	TOTAL(t)
LINING	ρ = 2.0 t/m3	2.3 t/m	4.5	630
INSULATION	ρ = 0.15 t/m3	0.2 t/m		
FOUNDATION	ρ = 2.4 t/m3	4,430 t		
SOIL ABOVE FOUNDATION	ρ = 1.8 t/m3	880 t		
WIND CONDITIONS [風荷重条件]				
MAXIMUM WIND VELOCITY (m/s)		50 AT 10 METER HEIGHT		
WIND PRESSURE (kg/m2)	h< 16 m	$45\sqrt{h}$		
	h≧ 16 m	$90\sqrt[4]{h}$		
CONDITIONS OF DYNAMIC ANALYSIS [動的解析条件]				
INPUT SEISMIC WAVE		EL CENTRO (NS) AND TAFT (EW)		
INPUT ACCELERATION (GAL)		150		
DAMPING RATIO		2 %		
RESULTS OF DYNAMIC ANALYSIS [動的解析結果]				
NATURAL PERIOD (sec)	1st mode	2.199		
	2nd mode	0.465		
	3rd mode	0.252		
MAXIMUM RESPONSE ACCELERATION (GAL)		888 (TAFT)		
MAXIMUM RESPONSE DISPLACEMENT (cm)		22.1 (EL CENTRO)		
MAXIMUM BENDING MOMENT (tm)		40,344.3 (EL CENTRO)		
MAXIMUM SHEAR FORCE (t)		1,021.2 (EL CENTRO)		
MAXIMUM SHEAR COEFFICIENT	TOP Ct	0.85		
	BOTTOM Cb	0.244		

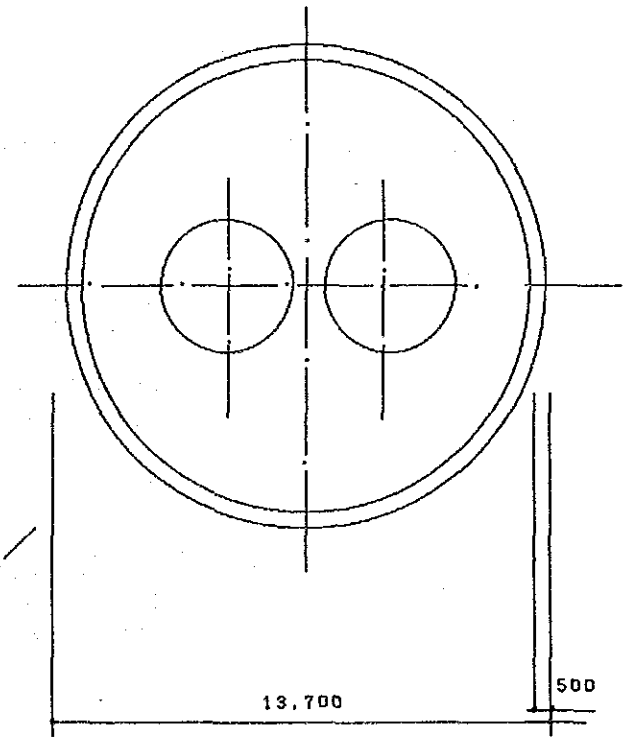
2-2 STRUCTURAL DRAWING [構造図]



ELEVATION



PLAN GL+137m



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3. DESIGN LOAD (1)
[設計荷重]

3-1 DEAD LOAD [固定荷重]

Dead load consists of concrete windshield, inner flue, lining, insulation and other accessories.

Unit weight of each material is as follows.

Reinforced concrete:	2.4 t/m3
Steel inner flue:	1.0 t/m (average thickness : 11mm)
Lining:	1.12 t/m (thickness : 50mm)
Insulation:	0.09 t/m (thickness : 50mm)
Soil:	1.8 t/m3

The weight of steel inner flue with lining and insulation is 2.21 t/m (=1+1.12+0.09). Total weight of two inner flues is 4.42 t/m (=2x2.21). Then the weight of inner flue for structural calculation is considered to be 4.5 t/m.

3-2 LIVE LOAD [積載荷重]

Live load is considered to be 100 kg/m2 for only the decision of stage members.

3-3 SEISMIC LOAD [地震荷重]

Seismic load is calculated from the dead load.

(1) Superstructure

The design shear force and bending moment are calculated at each level from the following equations.

$$Qi = Ci*W$$
$$Mi = 0.4*H*Ci*W$$

where, Qi : Shear force at the level of "i" (t)
Mi : Bending moment at the level of "i" (tm)
Ci : Coefficient indicating the stress distribution by height direction which is calculated from the following equation

$$Ci = 0.15*Z*(1-hi/H)$$

Z : Zone coefficient for earthquake magnitude (=1.0)
hi : Height from the ground level to the level of "i"
H : Height of chimeny from the ground level (m)
W : Total weight of chimney including inner flues

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3. DESIGN LOAD (2)
[設計荷重]

(2) Foundation

Seismic force of foundation is calculated from the following equation.

$$P = K*Wf$$
$$K = 0.05*Z*(1-h/40)$$

where, P : Seismic force of foundation (t)
K : Seismic coefficient
Wf : Weight of foundation (t)
Z : Zone coefficient for earthquake magnitude (=1.0)
h : Depth from the ground level (m)

3-4 WIND LOAD [風荷重]

Two kinds of wind loads are considered for the design wind load. One is static wind load and the other is resonant wind load. Static wind load is calculated from the maximum wind velocity. Resonant wind load is calculated from the wind velocity by which the chimney is resonated at the first mode. The static wind load by that wind velocity is combined with the resonant wind load by vector.

(1) Static wind load [静的風荷重]

The horizontal static wind load is calculated from the following equation.

$$Pi = C*qi*Di$$

where, Pi : Horizontal static wind load at the level of "i" (t/m)
C : Coefficient of wind pressure (=0.7 ; cylinder shape)
qi : Wind pressure at the level of "i" (kg/m2)
$qi = 90\sqrt[4]{hi}$
hi : Height from the ground level to the level of "i" (m)
Di : Outer diameter of chimney at the level of "i" (m)

3. DESIGN LOAD (3)
[設計荷重]

(2) Resonant wind load [揚力]

The resonant wind load due to Karman vortex is calculated from the following equation.

Pri = Cr*qr*Di

where, Pri: Resonant wind load at the level of "i" (t/m) (t/m)
Cr : Coefficient of wind pressure at resonance which is decided by the value of (Vr*D). Where, Vr is resonant wind velocity (m/s) and D is outer diameter (m) of chimney at the height of (2/3)H.
qr : Wind pressure at resonance (kg/m2)
Di : Outer diameter of chimney at the level of "i" (m)

(Detail explanation)

Vr:Resonant wind velocity (m/s)
Vr = D/(Sr*T)
where, D :Outer diameter of chimney at the height of (2/3)H (m)
Sr:Strouhal number
Sr=0.18 in case of Vr*D< 100
Sr=0.25 in case of Vr*D≧ 100
T :Natural period of chimney at the first mode (sec)

qr:Wind pressure at resonance (kg/m2)
qr = 1.5*qro*h/H
where, qro:Basic wind pressure at resonance (kg/m2)
qro=Vr*Vr/16
h :Height from the ground level (m)
H :Height of chimney from the ground level (m)

Cr:Coefficient of wind pressure at resonance decided from the following table

	$\rho\sqrt{\eta} < 1$	$1 \leqq \rho\sqrt{\eta}$
Vr*D<3	$(2.3+3.0*(1-\rho\sqrt{\eta})^{2})/\sqrt{\eta}$	$2.3/\sqrt{\eta}$
3≦ Vr*D<6	Linear interpolation	Linear interpolation
6≦ Vr*D<100	$(0.7+1.9*(1-\rho\sqrt{\eta})^{2})/\sqrt{\eta}$	$0.7/\sqrt{\eta}$

NOTE : η --- Damping ratio of chimney (2%)
ρ --- Relative density of chimney calculated as below (kg·sec2/m4)
ρ =W/(9.8*H*D*Db)
where, W :Weight of chimney (kg)
Db:Outer diameter of chimney bottom (m)

4. DESIGN OF SUPERSTRUCTURE (1)
[上部の設計]

4-1 STATIC ANALYSIS [静的解析]

4-1.1 STRESS ANALYSIS OF SEISMIC LOAD [地震時の応力解析]

Shear force and bending moment are calculated and the results are indicated in the following table.

Height hi (m)	Outer Diameter Di (m)	Thickness Ti (m)	Inner Diameter di (m)	Weight Wi (t)	Shear Force Qi (t)	Bending Moment Mi (tm)
137	10.20	0.25	9.70	0.0	0.0	0.0
130	10.38	0.26	9.85	135.8	39.7	2177.1
120	10.63	0.28	10.07	345.6	96.5	5287.3
110	10.89	0.30	10.29	574.7	153.2	8397.5
100	11.15	0.32	10.51	823.8	210.0	11507.6
90	11.40	0.34	10.73	1093.4	266.7	14617.8
80	11.66	0.35	10.95	1384.2	323.5	17728.0
70	11.91	0.37	11.17	1697.0	380.3	20838.1
60	12.17	0.39	11.39	2032.2	437.0	23948.3
50	12.42	0.41	11.61	2390.7	493.8	27058.5
40	12.68	0.43	11.82	2773.0	550.5	30168.6
30	12.93	0.45	12.04	3179.8	607.3	33278.8
20	13.19	0.46	12.26	3611.7	664.0	36389.0
10	13.44	0.48	12.48	4069.4	720.8	39499.1
0	13.70	0.50	12.70	4553.6	777.5	42609.3

4-1.2 STRESS ANALYSIS OF STATIC WIND LOAD [静的風圧力による応力解析]

Shear force and bending moment are calculated and the results are indicated in the following table.

Height hi (m)	Shear Force Qi (t)	Bending Moment Mi (tm)
137.0		
127.9	19.0	173.7
118.7	38.1	521.9
109.6	57.3	1045.0
100.5	76.4	1743.2
91.3	95.6	2616.1
82.2	114.6	3663.0
73.1	133.5	4882.5
63.9	152.2	6272.6
54.8	170.6	7830.6
45.7	188.5	9552.7
36.5	206.0	11433.7
27.4	222.6	13466.7
18.3	238.2	15642.1
9.1	252.1	17945.0
0.0	262.9	19145.8

4. DESIGN OF SUPERSTRUCTURE (2)
[上部の設計]

4-2 DYNAMIC SEISMIC ANALYSIS [動的地震応答解析]

4-2.1 Analysis conditions

a. The reinforced concrete windshield (H=137m) is divided into 15 parts in the same height with the mass concentrated in the center of each part. The mass of foundation is considered to be one mass.

b. Only flectional stiffness is considered for the analysis model of windshield. The stiffness of inner flues is not considered for the analysis.

c. The stiffness of sway and rocking is considered for the analysis model of foundation. The stiffness of steel pipe pile and soil is also considered for those stiffnesses. The stiffness is calculated as follows.

- Spring constant of sway stiffness : Ks (t/m)

  Ks = n x Kh*B/β = 3.428E05 t/m

  where, n : Number of pile (n=101 piles)
  Kh: Coefficient of ground reaction decided ground conditions (Kh=2.31kg/cm3)
  B : Pile diameter (B=60.96 cm)
  β : = $\sqrt[4]{Kh*B/(4*E*I)}$ = 0.004148 cm-1
  E = 2100 t/cm2 (Young modulus of steel pile)
  I = 76600 cm4 (Section inertia moment of steel pipe pile ϕ 609.6x9)

- Spring constant of rocking stiffness : Kr (tm/rad)

  Kr = α *E*Io/L = 1.218E08 tm/rad

  where, α : Coefficient considered ground effectiveness
  Io: Inertia moment of a group of steel pipe piles
  Io = 0.5*A*Σ (n*r*r)
  A :Section area of one steel pile (0.01698 m2)
  Σ :Sumation of all sizes of r
  n :Number of piles with the same size of r
  r :Radius of pile locations from the center of foundation (m)
  L : Pile length (25 m)

(Detail explanation)
Kh = 0.8*Eo*B$^{-3/4}$= 0.8*(7*9)*60.96$^{-3/4}$= 2.31 kg/cm3
where, Eo:Coefficient of soil deformation; =7*N (N:N-value)
α = λ *(λ *tanhλ +γ)/(γ *tanhλ +λ) = 1.744
where, γ =At*kv*L/(A*E) (At:Closed section area of pile bottom, kv:Coefficient of vertical ground reaction, L:pile length)
λ =L* $\sqrt{cs*U/(A*E)}$ (cs:Friction coefficient between pile and soil, U:Circumference of steel pipe pile)

4. DESIGN OF SUPERSTRUCTURE (3)
[上部の設計]

d. Damping ratio : h1 = h2 = h3 = 0.02

e. Maximum input acceleration : 150 gal

f. Input earthquake wave

EL CENTRO (1940 NS COMPONENT)

Number of data :	2,688
Time difference between data :	0.02 sec
Analysis period :	53.76 sec

TAFT (1952 EW COMPONENT)

Number of data :	2,720
Time difference between data :	0.02 sec
Analysis period :	54.40 sec

4. DESIGN OF SUPERSTRUCTURE (4)
[上部の設計]

4.2-2 Analysis model

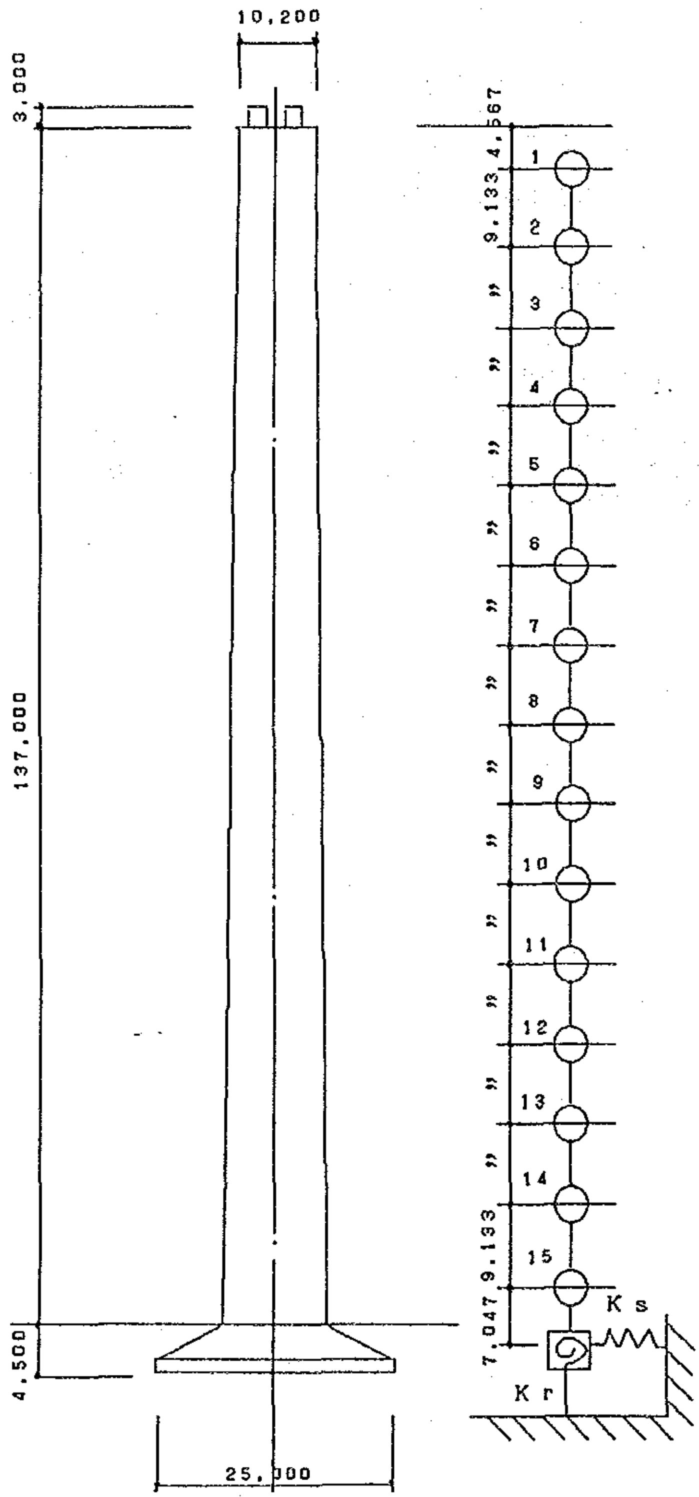

Table 2.1 DATA FOR VIBRATION MODEL

タイトル : WEST WHARF RC-STACK

＊＊＊＊＊ 振 動 モ デ ル ＊＊＊＊＊

Mass point 質 点		Height 高 さ (m)	Weight 重 量 (t)	Mass 質 量 (t.sec2/m)	Length of division 区間長 (m)	I Section inertia moment (m4)
1	O	132.433	233.556	23.832		
	|				9.133	0.110119E+03
2	O	123.300	235.703	24.051		
	|				9.133	0.124650E+03
3	O	114.167	251.847	25.699		
	|				9.133	0.140425E+03
4	O	105.033	268.489	27.397		
	|				9.133	0.157512E+03
5	O	95.900	285.629	29.146		
	|				9.133	0.175976E+03
6	O	86.767	303.265	30.945		
	|				9.133	0.195887E+03
7	O	77.634	321.399	32.796		
	|				9.133	0.217313E+03
8	O	68.500	340.031	34.697		
	|				9.133	0.240327E+03
9	O	59.367	359.159	36.649		
	|				9.133	0.265002E+03
10	O	50.234	378.785	38.652		
	|				9.133	0.291414E+03
11	O	41.100	398.909	40.705		
	|				9.133	0.319637E+03
12	O	31.967	419.529	42.809		
	|				9.133	0.349752E+03
13	O	22.834	440.647	44.964		
	|				9.133	0.381836E+03
14	O	13.700	462.263	47.170		
	|				9.133	0.415973E+03
15	O	4.567	484.402	49.429		
	|				4.567	0.442972E+03
	---	-2.480				

Young modulus ヤング係数 : 0.24400E+07 (t/m2)

		Weight of foundation 基礎体重量	Mass of foundation 質 量	Spring constant of sway stiffness スウェイバネ
16	(SWAY)	0.442100E+04 (t)	0.451122E+03	0.342800E+06 (t/m)

		Rotatory inertia moment 回転慣性モーメント	Mass 質 量	Spring constant of rocking stiffness 回 転 バ ネ
17	(ROCKING)	0.147000E+06 (tm2)	0.150000E+05	0.121800E+09 (tm/rad)

4. DESIGN OF SUPERSTRUCTURE (5)
[上部の設計]

4-2.3 Results of Dynamic Seismic Analysis

(1) Eigen value

Natural Period, modal particpation factor and mode shape of each mass at each mode are shown in the tables 4-2.2 and 4-2.3.

(2) Maximum response

Maximum response values are shown in the tables 4-2.4 and 4-2.5. Response displacement, acceleration, shear force and bending moment are indicated. Table 4-2.4 shows the results of EL CENTRO seismic wave and table 4-2.5 shows the results of TAFT seismic wave.

4-3 DYNAMIC ANALYSIS FOR RESONANT WIND LOAD

4-3.1 Calculation of initial data

Each data necessary to stress analysis is calculated and shown in the table 4-3.1.

4-3.2 Results of stress analysis

Shear force and bending moment by resonant wind load and by static wind load at resonant wind velocity are indicated in the table 4-3.2.
Shear force and bending moment by combined loads of the resonant wind load and the static wind load are shown in the table 4-3.3.

4-4 RESULTS OF ALL STRESS ANALYSIS

The results of all stress analysis are shown in the figures 4-4.1 to 4-4.6. The contents of the figures are as follows.

Figure 4-4.1 Vibration Mode Diagram 1 (U)
Figure 4-4.2 Vibration Mode Diagram 2 (β *U)
Figure 4-4.3 Maximum Displacement Response
Figure 4-4.4 Maximum Acceleration Response
Figure 4-4.5 Shear Force
Figure 4-4.6 Bending Moment

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/EC

Table 4-2.2 EIGEN VALUE (1)

タイトル : W E S T W H A R F RC-STACK

RESULTS OF EIGEN VALUE

***** 固 有 値 解 析 結 果 *****

Mode 次 数	1	2	3	4	5	6	7	8	9	10
Natural period 固有周期 (sec) (秒)	2.19868	0.46502	0.25232	0.15911	0.08876	0.05857	0.04209	0.03037	0.02239	0.01706
Participation factor 刺激係数	1.66070	1.31266	0.94518	-0.33283	0.04630	-0.00626	0.00216	-0.00233	-0.00136	0.00081
1	1.00000	-1.00000	1.00000	1.00000	1.00000	0.96095	-0.84115	-0.73222	0.61327	0.46804
2	0.90168	-0.66086	0.50182	0.31778	-0.01775	-0.34428	0.59672	0.83581	-1.00000	-1.00000
3	0.80395	-0.33431	0.04542	-0.26227	-0.72408	-1.00000	1.00000	0.80967	-0.39323	0.12543
4	0.70759	-0.03543	-0.32419	-0.64459	-0.91080	-0.75220	0.26541	-0.38937	0.91813	0.93638
5	0.61360	0.22079	-0.57031	-0.77505	-0.59144	0.06243	-0.70237	-1.00000	0.56680	-0.30552
6	0.52302	0.42240	-0.67449	-0.66112	0.00595	0.78261	-0.92464	-0.27368	-0.70961	-0.81707
7	0.43691	0.56215	-0.63972	-0.36686	0.56267	0.90671	-0.25721	0.74497	-0.72230	0.38977
8	0.35630	0.63816	-0.48834	0.00857	0.82198	0.40367	0.59858	0.76245	0.43625	0.72679
9	0.28214	0.65387	-0.25655	0.35943	0.69290	-0.33320	0.84731	-0.15240	0.82226	-0.40364
10	0.21531	0.61740	0.01288	0.59976	0.26679	-0.80098	0.32021	-0.82126	-0.10166	-0.67260
11	0.15656	0.54060	0.27818	0.68153	-0.24656	-0.72516	-0.45712	-0.47590	-0.80833	0.36830
12	0.10655	0.43793	0.50513	0.60137	-0.62331	-0.20586	-0.80391	0.40680	-0.24488	0.64594
13	0.06582	0.32527	0.67194	0.39623	-0.72101	0.38619	-0.48444	0.79965	0.66678	-0.30816
14	0.03480	0.21883	0.77199	0.13079	-0.52813	0.65971	0.12917	0.35887	0.61922	-0.69289
15	0.01384	0.13431	0.81451	-0.11920	-0.15530	0.42360	0.38165	-0.20219	-0.06896	-0.02519
16	0.00436	0.09180	0.82307	-0.26037	0.14699	-0.06174	0.03647	-0.06695	-0.06764	0.05827
17	0.00116	0.00530	-0.00081	0.01811	-0.04177	0.07579	0.06633	-0.04253	-0.02850	0.01933

Table 4-2.3 EIGEN VALUE (2)

タイトル : WEST WHARF RC-STACK

RESULTS OF EIGEN VALUE

***** 固 有 値 解 析 結 果 *****

Mode 次 数	11	12	13	14	15	16	17
Natural period 固有周期 (sec) (秒)	0.01344	0.01091	0.00912	0.00786	0.00698	0.00625	0.00407
Participation factor 刺激係数	-0.00046	-0.00026	-0.00018	0.00011	-0.00007	0.00006	-0.00020
1	0.38013	-0.31214	0.20235	0.12856	0.05791	0.00952	0.00000
2	-1.00000	0.96443	-0.70696	-0.49200	-0.23674	-0.04118	-0.00001
3	0.60353	-1.00000	1.00000	0.84857	0.46591	0.09013	0.00003
4	0.55133	0.15464	-0.75888	-1.00000	-0.69093	-0.15751	-0.00008
5	-0.90344	0.77306	0.11149	0.88154	0.88493	0.25094	0.00021
6	0.01252	-0.89970	0.56449	-0.49418	-1.00000	-0.37447	-0.00051
7	0.83711	0.11163	-0.82921	-0.05035	0.98308	0.52613	0.00123
8	-0.42673	0.74582	0.49382	0.54429	-0.79694	-0.69439	-0.00293
9	-0.59018	-0.73221	0.19349	-0.76328	0.44594	0.85516	0.00683
10	0.64626	-0.11693	-0.68855	0.58818	0.00483	-0.97176	-0.01563
11	0.31025	0.77908	0.57893	-0.10176	-0.43179	1.00000	0.03510
12	-0.71317	-0.44957	0.03517	-0.41985	0.68735	-0.90009	-0.07732
13	-0.06534	-0.42454	-0.58181	0.64971	-0.66112	0.65292	0.16781
14	0.73157	0.73207	0.56306	-0.45006	0.36445	-0.29250	-0.34149
15	0.09627	0.16097	0.18039	-0.20020	0.21983	-0.25085	1.00000
16	-0.05361	-0.05118	-0.04052	0.03549	-0.03300	0.03274	-0.08550
17	-0.01509	-0.01275	-0.00916	0.00748	-0.00659	0.00622	-0.01376

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Table 4-2.4 RESULTS OF DYNAMIC SEISMIC ANALYSIS (1)

タイトル : W E S T W H A R F RC-STACK

***** 地 震 応 答 解 析 結 果 *****

Earthquake wave 地震波タイトル : EL CENTRO (NS) MAY 18,1940 〔THE BUILDING CENTER〕
Maximum input accel. 入力最大加速度 : 150.000 G A L
Time step 計 算 刻 み : 0.020 秒 (sec)

Mass 質点	Height 高さ (m)	Displace 変位 (cm)	Time 時刻 (sec)	Acceleration 加速度 (gal)	Time 時刻 (sec)	Shear force せん断力 (ton)	Time 時刻 (sec)	Moment 転倒モーメント (t・m)	Time 時刻 (sec)
1	132.433	-22.083	6.54	-834.845	5.34	198.962	5.34	0.000	0.00
2	123.300	-19.268	6.54	-541.139	5.34	329.113	5.34	1817.180	5.34
3	114.167	-16.500	6.54	301.377	6.52	397.546	5.34	4823.068	5.34
4	105.033	-13.942	6.58	-178.989	5.74	406.448	5.36	8453.972	5.34
5	95.900	-12.021	6.66	324.467	2.58	-386.317	6.52	12159.805	5.34
6	86.767	10.841	5.58	450.883	2.58	-335.402	6.52	15459.062	5.34
7	77.634	9.614	5.58	494.154	2.58	271.932	5.74	18024.980	5.36
8	68.500	8.320	5.58	461.870	2.58	-304.936	6.66	-20025.824	6.52
9	59.367	6.987	5.58	-453.189	5.14	411.538	5.56	-21388.773	6.52
10	50.234	5.654	5.58	-425.201	5.14	529.037	5.56	-21726.832	6.52
11	41.100	4.368	5.58	-371.636	5.14	634.449	5.14	-21076.679	6.52
12	31.967	3.177	5.58	-381.953	2.82	764.071	5.14	-19578.534	6.52
13	22.834	2.132	5.58	-382.599	2.82	867.191	5.14	-21556.013	6.66
14	13.700	1.286	5.60	-363.784	2.82	945.124	5.12	28298.950	5.56
15	4.567	0.854	2.82	-347.564	2.56	1021.183	5.12	36123.886	5.58
	0.000							40344.260	5.58
FS	-2.480	0.701	2.82	-369.947	2.56	2409.173	2.82		
FR	-2.480	0.035	5.58	4.855	4.92			42635.958	5.58

Table 4-2.5 RESULTS OF DYNAMIC SEISMIC ANALYSIS (2)

タイトル : WEST WHARF RC-STACK

***** 地 震 応 答 解 析 結 果 *****

Earthquake wave 地震波タイトル : TAFT (EW) JUL 21,1952 (THE BUILDING CENTER)
Maximum input accel. 入力最大加速度 : 150.000 GAL
Time step 計 算 刻 み : 0.020 秒 (sec)

Mass 質点	Height 高さ (m)	Displacement 変位 (cm)	Time 時刻 (sec)	Acceleration 加速度 (gal)	Time 時刻 (sec)	Shear force せん断力 (ton)	Time 時刻 (sec)	Moment 転倒モーメント (t・m)	Time 時刻 (sec)
1	132.433	15.015	38.80	887.662	8.08	-211.549	8.08	0.000	0.00
2	123.300	13.516	38.80	-542.211	7.44	-341.031	8.08	-1932.145	8.08
3	114.167	12.037	38.82	271.630	6.78	397.317	7.44	-5046.879	8.08
4	105.033	10.593	38.82	-177.325	12.78	-399.668	6.74	-8653.757	8.08
5	95.900	9.205	38.84	-305.768	12.78	-355.077	6.76	-12142.724	6.74
6	86.767	7.876	38.86	-446.325	8.08	-279.627	6.78	-15304.616	6.74
7	77.634	6.888	5.88	-518.730	8.08	-209.918	4.98	-17580.204	6.74
8	68.500	5.926	5.86	-522.678	8.08	284.714	12.78	-18791.075	6.76
9	59.367	4.934	5.86	-494.219	8.10	379.419	5.88	-18899.444	6.76
10	50.234	3.934	5.86	-447.334	8.12	524.170	8.08	-17706.725	6.76
11	41.100	2.966	5.86	-394.249	7.66	642.107	8.10	-15365.222	6.78
12	31.967	-2.230	6.98	-344.150	7.66	743.859	8.10	13655.960	38.76
13	22.834	-1.567	6.98	-327.847	11.88	807.939	7.66	16913.853	5.88
14	13.700	1.048	12.40	-345.833	11.88	900.769	7.66	21732.631	5.88
15	4.567	0.760	12.40	-346.752	11.88	964.499	7.66	26630.885	5.86
	0.000							28945.282	5.86
FS	-2.480	0.617	12.40	-342.593	11.88	2126.261	11.88		
FR	-2.480	0.025	7.66	5.056	7.90			30238.216	7.66

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Table 4-3.1 INITIAL DATA FOR CALCULATION

タイトル : WEST WHARF RC-STACK

***** 風圧力解析 *****

NO.	Height 高さ (m)	Objected area 見付面積(m2)	Level レベル (m)	Diameter 外径 (m)	Thickness 厚さ (m)	Weight 重量 (t)
			137.000	10.200	0.250	0.000
1	132.433	94.225				
			127.867	10.433	0.267	178.956
2	123.300	96.356				
			118.733	10.667	0.283	373.559
3	114.167	98.487				
			109.600	10.900	0.300	584.306
4	105.033	100.618				
			100.467	11.133	0.317	811.696
5	95.900	102.750				
			91.334	11.367	0.333	1056.224
6	86.767	104.881				
			82.200	11.600	0.350	1318.390
7	77.634	107.012				
			73.067	11.833	0.367	1598.689
8	68.500	109.143				
			63.934	12.067	0.383	1897.620
9	59.367	111.274				
			54.800	12.300	0.400	2215.679
10	50.234	113.405				
			45.667	12.533	0.417	2553.364
11	41.100	115.536				
			36.534	12.767	0.433	2911.173
12	31.967	117.667				
			27.400	13.000	0.450	3289.602
13	22.834	119.798				
			18.267	13.233	0.467	3689.150
14	13.700	121.929				
			9.134	13.467	0.483	4110.313
15	4.567	124.067				
			0.000	13.700	0.500	4553.613

Dm	h1	P1	Vm	Vr	Sr	Vr*D	T1
11.400	0.02	1.00	49.23	20.74	0.25	236.43	2.1987

Cr = 14.120

[RHOs*ROOT(ETA) (1.0 , 100.0 (= Vr*D (Sr = 0.25)]

Table 4-3.2 RESULTS OF STRESS ANALYSIS BY WIND (1)

(1) 揚力,および共振風速に対する抗力　　< Vr = 20.74 m/sec >

NO.	高さ(m) Height	by Resonant wind load 揚力 せん断力(t) Shear force	by Resonant wind load 揚力 モーメント(t*m) Moment	by static wind load 抗力 せん断力(t) Shear force	by static wind load 抗力 モーメント(t*m) Moment
1	132.433		0.000		0.000
		51.865		1.773	
2	123.300		473.694		16.195
		101.244		3.586	
3	114.167		1398.389		48.951
		147.978		5.440	
4	105.033		2749.913		98.635
		191.903		7.333	
5	95.900		4502.616		165.612
		232.857		9.267	
6	86.767		6629.373		250.250
		270.680		11.241	
7	77.634		9101.577		352.914
		305.210		13.254	
8	68.500		11889.148		473.970
		336.283		15.308	
9	59.367		14960.524		613.786
		363.740		17.402	
10	50.234		18282.669		772.726
		387.417		19.536	
11	41.100		21821.065		951.158
		407.154		21.711	
12	31.967		25539.721		1149.448
		422.787		23.925	
13	22.834		29401.164		1367.962
		434.157		26.179	
14	13.700		33366.447		1607.067
		441.100		28.474	
15	4.567		37395.143		1867.127
		443.455		30.809	
16	0.000		39420.468		2007.835

Table 4-3.3 RESULTS OF STRESS ANALYSIS BY WIND (2)

(2) 揚力,および共振風速に対する抗力の合成応力 < SQRT(揚力**2 + 抗力**2) * 1.00 >

NO.	高さ (m) Height	せん断力 (t) Shear force	モーメント(t*m) Moment
1	132.433		0.000
		51.895	
2	123.300		473.971
		101.308	
3	114.167		1399.245
		148.078	
4	105.033		2751.681
		192.043	
5	95.900		4505.661
		233.042	
6	86.767		6634.094
		270.914	
7	77.634		9108.417
		305.497	
8	68.500		11898.592
		336.632	
9	59.367		14973.110
		364.156	
10	50.234		18298.991
		387.909	
11	41.100		21841.785
		407.732	
12	31.967		25565.574
		423.464	
13	22.834		29432.971
		434.945	
14	13.700		33405.127
		442.018	
15	4.567		37441.727
		444.524	
16	0.000		39471.568